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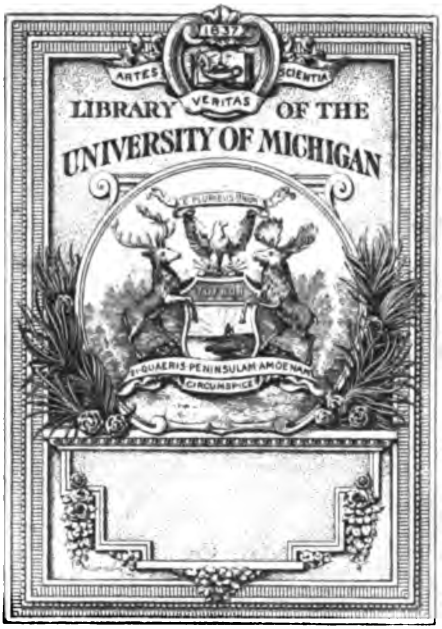
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NOTE ON
THE UTILISATION OF KHAIR FORESTS IN EASTERN BENGAL AND ASSAM

BY

MR. PURAN SINGH, F.C.S.
Acting Imperial Forest Chemist

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NOTE

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THE UTILISATION OF KHAIR FORESTS IN EASTERN BENGAL AND ASSAM.

By MR. PURAN SINGH, F.C.S., etc.,
Acting Imperial Forest Chemist.

It has been hitherto generally believed that Acacia Catechu growing in moist climates or on river banks contains no catechin and consequently yields no katha, and that it is unfit also for the manufacture of cutch. In Eastern Bengal and Assam the Acacia Catechu growing on river banks has been declared both by the Kumaon Katha boilers and the Burma Cutch makers to be useless for the manufacture of katha or cutch. The results of a chemical investigation of the two samples of this variety of Acacia Catechu growing in the Goalpara division near the Aie river received from the Conservator of Forests, Eastern Bengal and Assam, do not, however, bear out the declaration of Kumaon and Burma Cutch boilers and are more in accordance with the expectations of those who refuse to place full reliance on the statements of native workers.

Samples of the wood from Eastern Bengal and Assam were first directly assayed with the following results :—

——	Moisture.	Catechin.	Catechu tannin (nearly).	Methyl alcohol extract.	Aqueous extract dried at 100° C.
Sample No. 1 . .	10·7	2·8	7·6	10·4	12·5
Sample No. 2 . .	10·3	5·2	4·3	9·5	15·7

The wood in the form of saw dust was first air-dried for three days before extraction.

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A similar analysis of a sample of the wood of Acacia Catechu growing in dry localities of Siwalik division, United Provinces, gave the following results :—

Moisture.	Catechin.	Catechu tannin (nearly).	Methyl alcohol extract.	Aqueous extract dried at 100° C.
7·5	10·9	2·8	13·7	21·8

It will be seen from the above tables that the proportion of catechin in the Goalpara wood is much less than in the other, but the belief that the former variety contains no catechin at all proves to be groundless. The acceptance of this supposition appears to have been based on the supposition that the presence of much moisture in the wood of moist localities prevented the formation of catechin, and it is true that the quantity of moisture in the Goalpara tree is larger than in the trees growing in dry climates. In the moisture determination of one of the Goalpara samples (Sample No. 2) freshly received, the heart-wood gave 40·3 per cent., while the fresh heart-wood of the Siwalik tree contained only 25·4 per cent. of moisture. There is no doubt that environment has much to do with the formation of catechin and other substances in Acacia Catechu; but as regards the tree moisture, as I have observed in my Note on Cutch Analysis, this does not affect the catechin in the wood though water has an injurious effect on crystalline catechin when separated out of the wood.

3. From the assay of the Goalpara wood it was clear that it could yield catechu. Accordingly, the samples in the form of thin shavings were put in loose linen bags and boiled for half an hour in a small copper vessel with twenty times their weights of water. The extracts so obtained were evaporated down to the consistency of a paste-like mass which easily solidified on cooling. These extracts were then pressed down in the form of rounded lumps and resembled in every way the ordinary cutches met with in the Indian market. Their physical characteristics and chemical composition are given in the table below :—

——	Sample No. 1.	Sample No. 2.
Form and color	Hard rounded lump; very dark brown; reddish brown or buff when scratched.	Rounded lump. Outside, hard and reddish brown. Inside, soft and pale reddish.

——	Sample No. 1.	Sample No. 2.
Fracture, etc.	Lustrous fracture with air spaces.	Outer dry part, friable fracture. Inside, dense and compact in structure with no air spaces.
Moisture	10·1	9·7
Methyl Alcohol extract	73·5	66·0
Catechin	35·2	43·2
Catechu Tannin (nearly)	38·3	22·8
Non-tanning Sol.	7·4	16·4
Ash	7·7	7·2
Hot-water insoluble organic matter .	1·3	0·7

It will be seen from the above table that the methyl alcohol extract (the limit of which for good cutches is between 70 and 80 per cent.) is in one case 73·5, while in the other case it is 66·0 per cent. The sample No. 1 in the case of which the extract is 73·5 per cent. is, as will appear later on, decidedly superior to the other as a dyeing agent. This is also evident from the fact that No. 1 contains a greater percentage of catechu-tannin and less of catechin than the other. In chemical composition these cutches are more like the Kumaon katha than the Burma cutches, and it is suggested that katha could be refined from cutch extracted from the Assam Khair timber, leaving behind cutch almost free from catechin and on that account more valuable as a dye.

The amount of ash in these cutches is rather high. It is probably due to the fact that the greater amount of moisture brings with it into the tissues of the tree more mineral matter.

4. In the course of the assay of the sample woods and their aqueous extracts, it was found that when aqueous extracts of these samples were being made, catechin did not undergo much decomposition as is the case

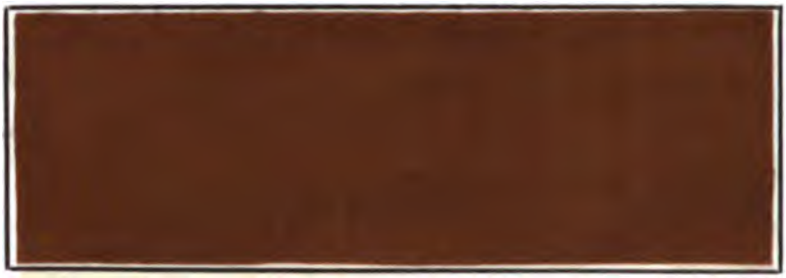
in general when Acacia Catechu is extracted with water. This would be clear from the following table :—

—	Percentage of aqueous extract dried at 100° C.	Percentage of catechin in the wood.	Percentage of catechin in the cutch made from the wood
Siwalik wood	21·8	10·9	34·9
Goalpara wood, No. 1 . . .	12·5	2·8	35·2
Goalpara wood, No. 2 . . .	15·7	5·2	43·2

The Siwalik wood contains more catechin than the Goalpara wood, and yet the percentage of catechin in the cutch made from the former is comparatively very much lower than in the cutches extracted from the latter, so that during the extraction of the wood for cutch making, catechin underwent very slight decomposition in the case of the Goalpara wood as compared with its amount of decomposition in the case of the Siwalik wood. The methyl alcohol extract of the Goalpara wood, when examined under the microscope, showed no crystals of catechin as the extracts of the Siwalik wood and other Acacia Catechus show in general; but catechin was seen there in its amorphous condition as a delicate powdery substance. This probably may account for the unusual behaviour of catechin in the presence of boiling water in this case. The crystalline catechin, it is well known, is easily decomposed when in contact with hot water, and that is why a considerable proportion of catechin in the cutch made from the Siwalik wood is eliminated. In the Goalpara wood, however, catechin is not present in the form of crystals. It is there in its amorphous state and during the extraction of the wood remains mostly unaffected by boiling water which in this case has little decomposing action but only changes the substance into its crystalline form. Thus the Khair wood of Goalpara and other similar moist localities would yield practically the whole of its catechin even when extracted with water.

5. To determine the value of the cutches made from the Goalpara wood, dyeing experiments were made with these according to the process adopted by Professor Hummel and Mr. Brown in their investigation of the dyeing properties of the different samples of Indian cutch submitted to them for examination by the Imperial Institute. This process was conducted as follows :— "Ten grams of the cutch sample were extracted

Samples of Linen dyed with Assam Cutch. *Plate* I.



I. a Dyed with Cutch and $CuSO_4$.

I. b The same after chroming.

I. c The same after repeated stuffing and saddening.

Samples of Linen dyed with Assam Cutch. *Plate* II.

II. a Dyed with Cutch and $CuSO_4$.

II. b The same after chroming.

II. c The same after repeated stuffing and saddening.

with water at 80°-90° C. for one hour, 1 gram $CuSO_4$ added, and a piece of cotton cloth weighing 10 grams entered into the bath. The above temperature was maintained with constant level for one hour, and the cotton allowed to cool for four hours in the liquor; at the end of this period one-third of the pattern was retained without further treatment, the remainder saddened for 10 minutes at the boil in a bath containing 2 grams $K_2 Cr_2 O_7$, per litre. At this stage another portion of the pattern was retained and the remaining third of the original piece was subjected to a repetition of the dyeing and saddening operations."

The results of these dyeing experiments are tabulated below :—

—	Pattern dyed with Cutch + $CuSO_4$. (*a*)	The same after chroming. (*b*)	The same after repeated stuffing and saddening. (*c*)
Cutch No. 1 . .	Yellowish brown	Reddish brown	Rich dark brown.
Cutch No. 2 . .	Pale yellowish brown.	Pale reddish brown.	Deep reddish brown.

These dyeing experiments show that cutch No. 1 is of a very high quality for the purpose of cotton dyeing Cutch No. 2 gives a reddish brown dye which has very little depth of colour, thus behaving like gambier exported from Singapore. The quality of the latter as a dye will be improved after the bulk of catechin has been removed from it. It is the bulk of catechin in it which makes it behave like gambier.

The samples of linen dyed on a commercial scale with cutch No. 1 and cutch No. 2 are shown in plate Nos. I and II respectively in three stages (*a*), (*b*) and (*c*).

6. The local cutch makers are said to have declared themselves incapable of making katha or cutch from the Goalpara wood. But it is evident from the results given above that the wood is suitable for the manufacture both of katha and cutch. There is no doubt that Acacia Catechu with white spots yields more extract and greater amount of catechin than that without spots, but that is no reason why a wood without white spots, should be declared wholly unfit for katha-making. In the light of the fact that the Goalpara wood which is without spots yields a cutch with a fairly high percentage of catechin, the practice of declaring all woods without white spots unsuitable for katha manufacture appears to be rather absurd. As observed in paragraph 4 of this

Note, catechin is present in the Goalpara wood in its amorphous condition and undergoes only slight decomposition during the extraction of the wood with water, so that the cutch made from it contains comparatively greater percentage of catechin than cutches made from spotted wood, where the amount of decomposition of catechin during extraction is considerable. To see, then, whether or no a tree is suitable for yielding katha, the presence or otherwise of white spots in it cannot be wholly relied on, and I recommend that a preliminary assay of the tree to be felled be made according to the following process :—

Take by means of a long borer about 2 grams of the heart-wood of the tree and let it dry in the sun to drive off the excess of moisture. Then extract a weighed quantity of wood with hot methyl alcohol by means of small quantities of the latter at a time. Evaporate the extract down to a paste-like mass and then digest it with "catechin mixture," carefully pestling the whole mass for the purpose of thorough digestion. Now filter and thoroughly wash the residue with "catechin mixture." "Catechin mixture" is a mixture of Ether and Carbon bisulphide (4 : 1). Let the filtrate together with the washings evaporate spontaneously or by means of blowing air into it. When completely dried, weigh it as catechin. The woods yielding above 3 per cent. of catechin may be regarded as suitable for katha-making, and cutches made from them should always be refined for the manufacture of catechin or katha. The manufacture of katha from the wood with less than 3 per cent. of catechin cannot be remunerative, and such wood may be considered suitable only for cutch-making.

7. About 17 years ago, Dr. Warth proposed to establish a Government Central Factory with improved appliances in India for the manufacture of both katha and cutch from all kinds of Khair wood. This proposal was not entertained for various reasons. Dr. Warth's method for refining cutch for katha-making cannot yield sufficient quantities of the latter to make his process remunerative, for catechin exists in cutches as crystals and is mostly decomposed during extraction of the cutch with hot water. But, as pointed out above, catechin in the wood of moist localities exists as amorphous and undergoes but slight decomposition when this wood is extracted with hot water for cutch-making, so that Dr. Warth's simple method for the extraction of cutch from the wood may be safely adopted for working the forests of moist localities. The cutch obtained by Dr. Warth's method may then be refined for the manufacture of katha according to my process presently to be described.

In the correspondence that ensued the above-mentioned proposal of Dr. Warth, an opinion was expressed both by the Assam and the Burma

Forest Officers that the extraction of catechin from cutch would lower the value of the latter as a dyeing agent. But it has been established beyond doubt by subsequent investigations on the dyeing properties of cutch and its constituents that this opinion is an unwarrantable one. There is no doubt that catechin being itself a dyeing agent, does make up to an appreciable extent for the deficiency of catechu-tannin in a poor sample of cutch, but in a cutch which contains a fairly large percentage of catechu-tannin the presence of much catechin has been found to be rather detracting from the depth of colour of the dye fixed on the cotton. It is therefore extremely desirable that as much of catechin should be extracted as possible from cutch. This is advantageous in a two-fold manner, (1) it gives katha which consists chiefly of catechin as a by-product, and (2) it concentrates the proportion of tannin in the cutch and thus enhances its value as a dye. I am aware of the financial failure of the Departmental experiments which were made by the Assam Government, about 17 years ago, to manufacture cutch from Darrang Khair. The cutch made in those experiments was found to be of an inferior quality. The reason I assign for this is that the cutch was not refined and contained a large quantity of catechin and consequently was found to be necessarily of a low quality as compared with Burma cutch which always contains a low percentage of catechin. I am further aware of another opinion expressed in the correspondence referred to above "that results are frequently obtained in a Laboratory which cannot be realized when dealing with large quantities." But in spite of this I am certain that it is possible to organise a remunerative industry by working the Assam Khair forests on the following lines :—

The finely-cut wood should be first extracted with water according to Dr. Warth's process, that is, it should be boiled for half an hour in *copper* cauldrons with ten to twenty times its weight of water. After the removal of wood splinters from the decoction it should be evaporated till it is nearly solid. If the wood by preliminary estimation has been found to contain less than 3 per cent. of catechin, the extract so obtained will be cutch of a high quality readily saleable in the European market and need not be refined for the extraction of katha.

In the case of woods estimated previously to contain more than 3 per cent. of catechin, the extract obtained as above will need refining, which may be effected by the following simple method which was first proposed together with an improved method of preparing pure catechin in my Note on Cutch Analysis and Preparation of Pure Catechin.

The cutch should be treated with cold crude wood spirit in ordinary closed casks with occasional shaking for about 12 hours and then filtered through a thick cloth. It is recommended that before treatment with wood spirit cutch should be put in loose linen bags. This would facilitate the removal of the cutch from the casks and render the process of filtration easy. These bags are then to be removed from the casks and pressed to remove the spirit from the cutch. The cutch by this treatment is rid of most of its catechin which goes to the filtrate and thus after drying will be found to be of a high quality as a dye. The filtrate, which contains almost all the catechin contained in the extract and a small proportion of its catechu-tannin, should then be put in a still and distilled. Most of the wood spirit is thus recovered and may be used again for further extraction of cutch. The loss in the quantity of spirit that occurs is estimated to be about 30 per cent. What remains in the still should be taken out, washed with cold water and thoroughly dried in warm air. These washings may be thrown in copper cauldrons. It will be the purest katha yet brought on the Indian market for sale and will be in quantity large enough to make the extraction of katha from cutch sufficiently remunerative. The purity of the katha so obtained will, it is hoped, more than compensate for the extra cost on wood spirit. The wood spirit, it may be remarked here, is cheap enough even now, but there are prospects of its becoming cheaper still when the manufacture of wood spirit is started on a large scale in India.

As pointed out in my Note on Cutch Analysis, etc., a great saving in the expenditure of refining cutch for katha making can be effected in a joint factory where the distillation of wood spirit is carried on side by side with the manufacture of cutch and katha.

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THE BARK-BORING BEETLE ATTACK IN THE CONIFEROUS FORESTS IN THE SIMLA CATCHMENT AREA

By E. P. STEBBING, F.L.S., F.Z.S., F.E.S.
Imperial Forest Zoologist.

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Forest Pamphlet No. 1, Chemistry Series No. 1.—**Note on the Utilisation of Khair Forests in Eastern Bengal and Assam** by Mr. Puran Singh, Acting Imperial Forest Chemist.

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THE BARK-BORING BEETLE ATTACK IN THE CONIFEROUS FORESTS IN THE SIMLA CATCHMENT AREA.

On March 26th 1908 I received from Mr. Munro, Deputy Conservator, Simla Forest Division, some portions of green deodar saplings together with a communication informing me that the trees appeared to be attacked by one or more insects. An inspection showed that the saplings were very badly infested (cf. Plate III) by the bark-boring beetles, *Scolytus major* and *Scolytus minor*, two of the worst pests, as far as is at present known, the deodar has to contend with. So serious did I consider this attack to be that I intimated to Mr. Munro my readiness to go up and inspect the area if it contained many more examples of trees infested in a manner similar to the ones sent to me. On the receipt of his reply I made arrangements to go up and inspect the Catchment Area and spent from April 8th to April 12th in the forests there. An inspection showed that the position was sufficiently serious as, in addition to the *Scolytus* beetle pests which confined themselves to the deodar, the blue pine bark-borer, *Polygraphus major*, was present in these trees in considerable numbers and was also infesting the deodar. Our knowledge of the habits of this beetle has shown that it only attacks the deodar when there is an insufficiency of its own proper food supply, *i.e.*, of blue pine trees. Ordinarily these three beetles only commence work (after the winter rest) at the beginning of May. Owing however to the long drought and warm early spring the insects are from 3-4 weeks ahead of their usual time of appearance and they are now (9th April) engaged in laying the eggs of the first generation of the year in the trees.

The presence of these three bark-boring beetles on the area is in itself a matter for serious uneasiness, but the outlook is rendered worse by the fact that there is yet a fourth beetle, belonging to the family *Buprestidæ*, attacking the deodar. From the evidence of last year's attacks it would appear to be unusually plentiful in parts of the forest, more especially perhaps in the Coppice Working Circle. Evidence of its attacks has however been also found in the forest Working Circles. This pest is an entirely new one to me, and beyond the fact that I took some of its larvæ in a deodar sapling in Bushahr in June 1901 nothing is known upon the subject of its life history. It is therefore almost impossible, as yet, to prescribe any remedies or to institute methods of combating it. A few larvæ were taken on April 9th in a green deodar tree which was badly attacked by this and the *Scolytus* beetles. A dead beetle, which is not unlikely to prove the insect whose larvæ are responsible for this damage, was taken by Mr. Munro at the end of a larval gallery. I cut the insect out myself and believe it is the one concerned in this attack. Unlike the bark-borers this pest has not yet begun to work (April 12th) and so no steps can at present be taken to deal with it in order to endeavour to stamp it out of the area. Careful and close observations are required during the next few months.

I propose here to deal with each of these beetles, describing their appearance, life history, damage committed and the steps which should be taken to combat them.

References are also made to their natural enemies. Each insect is figured in the plates which also depict the method of attack of each pest in the tree.

THE DEODAR BARK-BORING BEETLES.

(*Scolytus major*, Steb. and *S. minor*, Steb.)

Vernacular names:—*Unknown.*

References:—*Departmental Notes on Insect that affect Forestry, Vol. I, pp. 45-48 (Scolytus sp.) pp. 203-212.*

Nature of Attack.

The female beetle bores through the bark of the deodar and eats out a gallery in the bast and sap wood in which she deposits her eggs; the larvæ on hatching out bore away from the female gallery eating out galleries in the bast layer, the galleries grooving the sap wood. When sufficiently numerous the beetles and their larvæ remove the whole of the bast or cambium layer of the tree which then dies.

Distribution.

The known distribution of the insect and of its companion the smaller deodar bark-borer (*Scolytus minor*, Steb.) is throughout the Jaunsar and Tehri Garhwal Deodar Forests and the Simla and Bashahr Deodar areas. It is probably distributed throughout the Deodar tracts of the Western Himalaya.

SCOLYTUS MAJOR.

(*The larger Deodar bark-borer.*)

General Appearance.

Egg.—The *egg* is spherical in shape, yellow in colour and shining. It is very small, being about 1/20th inch in diameter.

Grub or *larva.*—The *larva* is small, curved, legless and white in colour. It is largest across at the head end. When full grown it is from 1/5th to ¼th inch in length.

On first hatching out the grub is a minute white dot. The curved shape is however easily recognisable by the time it has bored about ¼ inch away from the egg gallery. Plate 1, fig. 1, shows the larva.

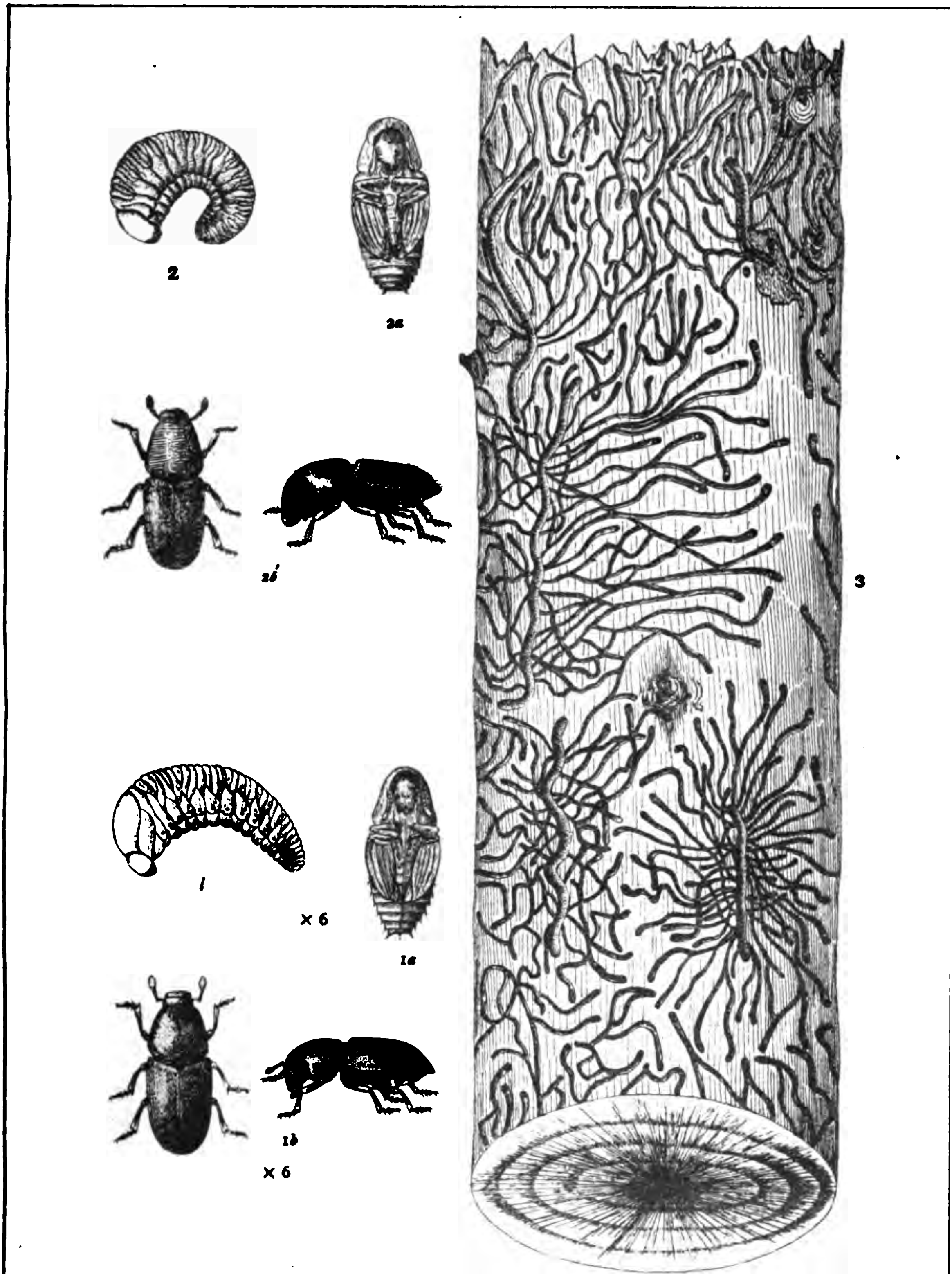
Pupa.—The *pupa* is white and has the general shape of the beetle; but all the parts are soft, the legs, antennæ, and wings being held pressed against the breast as shown in fig. 1a. Length ⅙th inch.

Beetle.—The *beetle* is small, black and shining, elongate and cylindrical. It is easily recognised by its hard shining outer covering and by the fact that the under part of its body behind is flexed or bent upwards as seen in the side view of the beetle shown in figure 3. The thorax or front upper portion of the insect is very smooth and shining, the elytra or posterior upper part of the beetle is not so shining, having small pits or indentations scattered over it. The length of the insect is from 1/5th to ¼th of an inch. Fig. 1b shows a side and back view of the beetle.

Life History.

Scolytus major passes through the winter either as a larva at the end of its gallery in the bast layer of the tree or as a mature beetle in the thicker parts of the old bark of deodar trees. It only bores into this old bark to obtain a shelter from the cold of the winter months and hibernates in this position. As soon as the first warmth of spring makes itself felt the overwintering larvæ change to pupæ in their galleries and then, in a week or 10 days, become mature beetles and bore their way out of the tree and seek other trees in which to lay their eggs. At the same period the mature beetles which have passed the winter in the old bark of deodar trees come out and seek suitable trees in which to oviposit. The eggs laid at this period are those of the first generation of the year. The exact time at which egg laying begins varies according to whether an early or late spring is experienced. This year (1908) a very early spring has followed a dry winter which in its turn was preceded by a very early closing of the monsoon of 1907. This, from observations made in the forest on the Simla Catchment Area, has resulted in the beetles commencing operations very early—at least 3-4 weeks earlier than usual. On the 9th of April beetles of the last generation of last year (November) were found mature at the end of the larval galleries of infested trees whilst others were found attacking fresh trees.

The beetles pair outside the tree. The insect's method of attack from the outside and its operations within the tree are constant and are easily recognisable. As is usual with the bark-borers of this family (*Scolytidæ*) the female commences by boring a small "shot-hole" through the bark in order to reach the bast layer. This may be made anywhere on the tree (save in the smaller branches of the crown which are not attacked), but the insect usually chooses a projecting flake of bark in order to screen itself. In the case of small saplings it usually bores in beneath a branch at the juncture of the latter with the main stem. On reaching the bast layer the beetle carries its gallery in an upward direction parallel to the long axis of the tree. The gallery is made mainly in the



1 and 2. The Deodar bark-borers: 1. *Scolytus major*, *Steb.* 1, larva; 1a, pupa; 1b, back and side view of beetle.

2. *Scolytus minor*, *Steb.* 2, larva; 2a, pupa; 2b, back and side view of beetle.

3. Portion of young deodar sapling showing the egg and larval galleries in the sap-wood.

(From the Simla Catchment Area).

bast layer, but it also grooves more or less deeply the sap wood: it is deeper and stronger at its commencement than at the upper end. The gallery so made is the egg gallery; it is from 2 to 3 inches in length and is carried upwards in a series of serpentine curves, first to one side and then to the other (Pl. II, fig. 1). The egg galleries made in the boles of large trees are usually shorter than those made in saplings, poles and branches. On either side of the egg gallery, as she gnaws it out upwards, the beetle bites out small indentations in the wood, in each of which she places an egg surrounded by small fine particles of wood dust; these egg notches do not begin quite at the bottom of the egg gallery, a small portion of it being left entire; they are however always made right to the extreme upper end, the number cut on either side being identical. As the gallery progresses upwards the beetle keeps it quite free from particles of wood by shovelling out with her legs all the wood dust, etc., eaten out in constructing it. These she ejects through the entrance hole in the bark; a portion of these wood particles is also passed through the body of the insect and ejected. When the beetle has finished egg laying she does not die, as is usual amongst bark-borers, but remains in the egg gallery or entrance tunnel in the bark, both of which she keeps quite free of wood dust. The mother beetle may be found alive in the tunnel when most of the larvæ from the eggs she has laid have become full grown and are pupating. The beetle probably remains alive in order to protect the eggs and larvæ from predaceous insects who could otherwise enter the exposed gallery from the outside and destroy the eggs and larvæ it contains. When she finally dies it is usually in the entrance tunnel in the bark which she thus blocks up effectually, as with a cork. The egg gallery takes from 5-7 days to make. The larvæ hatch from the eggs within a couple of days: young larvæ from the eggs first laid may be found already hatched out and at work boring their galleries whilst the mother is still at work completing the egg gallery above and egg laying.

Between 60-70 eggs are laid in the egg gallery, approximately 30-35 on each side. The larvæ on hatching out bore in the bast and sap wood; they carry their galleries in a direction away from the egg gallery, those in the centre eating away in a direction more or less at right angles, whilst the galleries of those above and below trend away from the right angle in an upward or downward direc tion. In this way an invariably uniform and constant pattern is made which remains indelibly impressed on the sap wood (cf. Pl. I, fig. 3, Pl. II, fig. 1). The presence of the beetle in a forest is thus recognized and identified with ease from these patterns which it leaves behind it in the trees it has attacked.

The larval galleries curve irregularly to a slight extent and increase in size with the growth of the grub; at the end when the larvæ are full grown they are about the same width as the egg gallery or slightly wider and are from 2½ to 3¾ inches in length. The galleries made by the larvæ of the first laid eggs are the strongest marked and often the longest. When full fed the larva changes to a pupa at the end of its gallery. In the case of large trees the gallery may be slightly enlarged at the extremity, a small depression being eaten out in the bark or sap wood. In poles, saplings and the upper parts of large trees the grub appears to invariably bore down into the sap wood at the end of its larval gallery, eating out a small tunnel or chamber of sufficient size to take its entire body; having done this it backs out from the chamber so made, turns round, and backs down into it again and then pupates. The larva takes about 4 weeks to reach full growth. The beetle on maturing crawls out of the chamber and bores its way straight through the bark of the tree and flies off to find a mate and, if a female, to lay eggs in a fresh tree. The time passed in the pupal stage is about 2 weeks, the total period of a generation from egg to mature beetle being about 6-7 weeks.

The above describes the life history of one generation or life cycle of the insect but does not account for the life of the species throughout the year. It has been found that it passes through several of these generations in a year, the actual number depending upon the climatic conditions of the early and late parts of the season. The insect has been found in the mature larval and immature pupal stage in the second week of November, this being the overwintering generation with which we started the account of the life history.

In a dry year such as the present (1908) when the insect has commenced work as early as the end of the first week in April, the following generations may be expected during the year (the weeks given are more or less approximate but should prove sufficiently accurate for working purposes):—

GENERATION I.

End of 1st week April	EGGS.
2nd week April to 2nd week May	Larvæ.
„ „ May „ end of month	Pupæ.
3rd „ „ „ 1st week June	BEETLES.

GENERATION II.

4th week in May	EGGS.
„ „ „ „ to end of June	Larvæ.
End of June to middle of July	Pupæ.
1st week of July to 3rd week of July	BEETLES.

GENERATION III.

2nd week of July	EGGS.
„ „ in „ to 2nd week in August	Larvæ.
„ „ of August to end of month	Pupæ.
3rd „ in „ „ 1st week September	BEETLES.

GENERATION IV.

4th week in August	EGGS.
„ „ „ „ to 4th week in September	Larvæ.
„ „ „ September to middle of October	Pupæ.
1st „ „ October to 3rd week in „	BEETLES.

GENERATION V. (A partial generation.)

2nd week in October	EGGS.
„ „ „ „ to 2nd week in November	Larvæ.
(Some of these larvæ will be overwintering larvæ.)	
„ week in November to end of November	Pupæ.
3rd „ „ „	BEETLES.
(These beetles will hibernate through the winter in thick deodar bark.)	

In ordinary years the beetle passes through 3 to 4 generations (the last a partial one) in the course of a year.

Damage Committed in the Forest.

This beetle is a most dangerous pest to the deodar and is, as far as is at present known, one of the worst insect foes the tree has to contend with. Trees of all sizes are attacked by the beetle from the largest tree in the forest to the smallest sapling. It usually confines its attacks to sickly trees and trees broken by snow or from other causes, in all of which the vitality has become lessened and the upward flow of sap consequently decreased; it also invariably lays its eggs in newly felled unbarked trees when such are available. In forests where such trees are not available or where circumstances have favoured the insect, such as a long drought and warm winter followed by an early spring, the latter will increase in such numbers that the ordinary supply of trees suitable for egg laying becomes insufficient: the beetle will then attack green standing healthy trees. When this happens it is usually found that the insect chooses those which are growing on exposed aspects where the soil is poor and those growing in open forest. Once, however, a centre of attack has started the insect, by means of successive generations, spreads outwards from the centre in more or less concentric rings, each generation attacking the trees nearest to those in which it was reared. In this way in serious attacks of the insect whole areas of forest may be killed off in a few months owing to the incredible swiftness with which the beetles multiply. That this latter is very rapid will be understood when it is stated that a tree of 3 feet diameter at base and 100 feet bole produced, as a result of a single generation reared in it, 56,300 beetles allowing for 50 per cent. casualties. Observations have shown that in a dry year such as the present the casualties have been from 15 to 20 per cent. only. Plate III, figs. 1, 2 and 3, show the effects of the insects' attacks on young deodar in the Catchment Area. The trees shown were killed by the beetle.

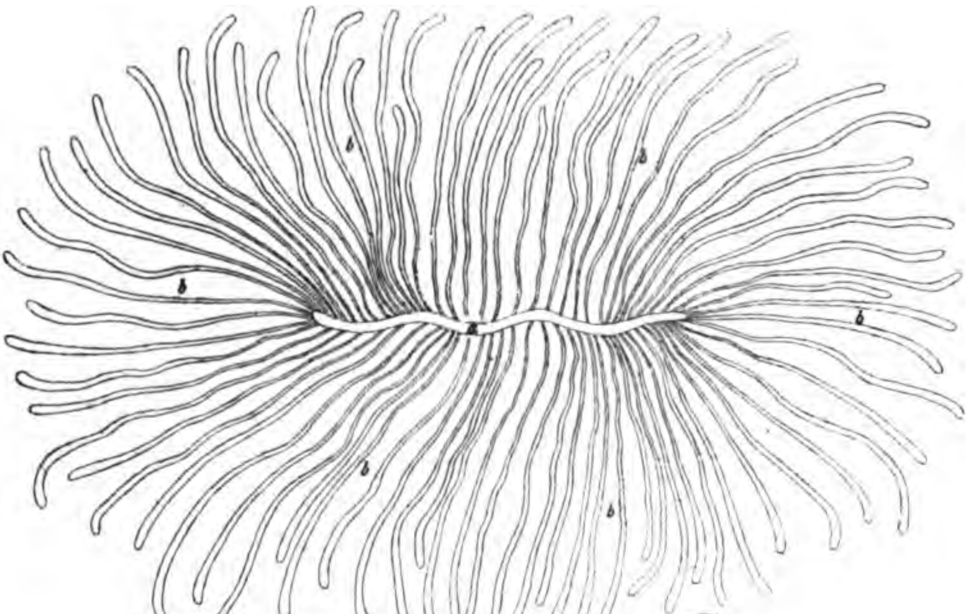
SCOLYTUS MINOR.

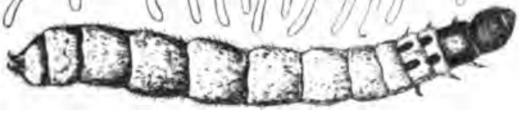
(*The smaller Deodar bark-borer.*)

The egg, larva and pupa of this insect resemble those of *Scolytus major* in every particular save that they are about half the size. Figs. 2, 2a (Plate I) show the larva and pupa of this insect.

Beetle.—The beetle resembles *Scolytus major* in shape and colouration. It is distinguishable in being half the size of its large companion and the pits and depressions on the elytra are more irregularly distributed. (Plate I, fig. 2b.)

This insect lays only half the number of eggs laid by its larger companion and usually confines its attacks to the tops of old trees and poles or to saplings.





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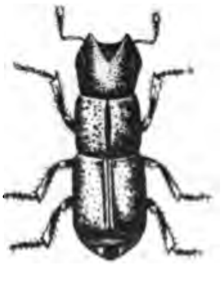
2*a*

2*b*



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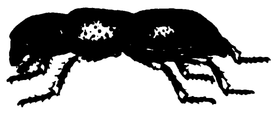


3*a*

1. Plan of egg and larval galleries of *Scolytus major*, the Deodar bark-borer : *a*, egg gallery ; *b*, larval galleries. 2. Predaceous clerid beetle (*Thanasimus himalayensis*, *Steb.*) : 2, larva (*mag.*), 2*a*, beetle siezing a *Scolytus*, 2*b*, beetle feeding upon one. 3. Predaceous histerid beetle (Niponius canalicollis, Lewis) : 3*a*, side view of do.

Natural Enemies.

Two insects are known to prey upon the *Scolytus* bark-borers, both beetles. One is a brightly coloured beetle which attacks the bark-borers outside the trees, the other follows them down into their tunnels and feeds upon them there. The larvæ of both are pink and prey upon the eggs and grubs of the *Scolytus* in their galleries.

1. *Thanasimus himalayensis,* Steb.

Reference:—*Departmental Notes, Vol. 1, pp. 213-218.*

This insect may be called the predaceous bark-beetle eating Clerid (it belongs to the family *Cleridæ*), for it feeds upon all the important Himalayan coniferous bark-beetle pests at present known.

Larva.—An elongate pink worm-like flat grub consisting of a head and twelve body segments. The head is brown and mandibles black; there is a brown patch just behind the head on the upper surface and a pair of brown spots on each of the two following segments. Each of the first 3 segments has a pair of legs and the grub tapers in front. Length ¾ to ⅞ inch. See plate II. fig. 2.

Beetle.—Head and antennæ black; body short and squarish with well marked "shoulders." The prothorax (part following head) is black and has some hairs on it. The body, which is covered by the elytra or wing cases on top, is broader than prothorax and head; the wing cases are rounded at extremities; the basal third being red, the rest black; the black area is traversed by two white wavy bands. The abdomen below is bright vermillion. Length about ½ inch. Plate II, figs. 2a, 2b shows this beetle.

The larvæ of this beetle are to be found in the tunnels of the *Scolytus* larvæ where they feed upon them, moving from one gallery to another between the bark and cambium layer.

The beetles are to be found on the wing in the forest flying about over or running along the trunks of infested trees. They are very active and seize with their powerful mandibles or jaws the *Scolytus* beetles they find on the trunk or just boring into the tree. Having caught a beetle they hold it between their fore legs, tear off the head, and then suck out the contents of the rest of the body. They are voracious insects and consume a large number of beetles. The *Thanasimus* is thus of great service to the Forester and should be carefully made known to forest guards and others in order that it may not be ignorantly destroyed as a pest.

2. *Niponius canalicollis, Lewis.*

Reference:—*Departmental Notes, Vol. I. pp. 248, 349.*

This is a beetle belonging to the family *Histeridæ*. It follows the *Scolytus* beetles into their tunnels and destroys them. Although more elongate it has a general resemblance to the *Scolytus* beetles, being black and shining in appearance, and efforts should be made to distinguish it from the deodar pest.

Larva.—Elongate and flat, pink in colour, with a yellow head and 12 pink or red body segments. Length ½ inch.

It is to be commonly found in the larval galleries of the *Scolytus* beetles in the same position as the last.

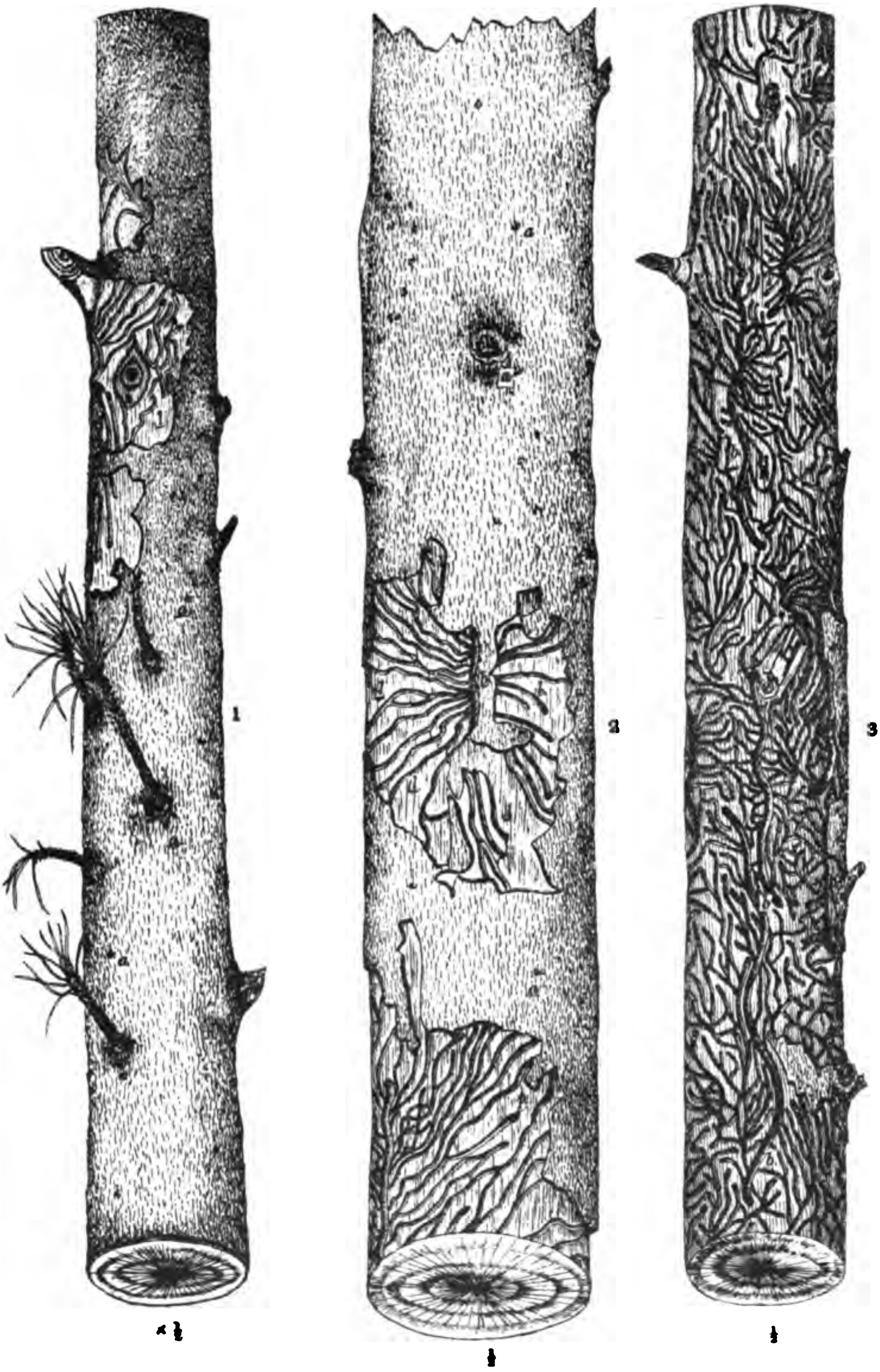
Beetle.—Elongate, narrow. Shining black in colour; the wing cases on the back are short and leave exposed two segments of the body. By this and its shape it can be recognised from the *Scolytus*. Its body also is not turned up at the end beneath as is that of the *Scolytus*. See side and back view of this beetle in Plate II, figs. 3, 3a.

This beetle feeds upon the *Scolytus* beetles. It has the same diameter as that of the deodar bark-boring beetles and can thus enter the tunnels of the latter to devour them.

Since this insect is an enemy of the bark-borer it should not be killed and efforts should be made to recognise it and its larvæ. It is always to be found with the *Scolytus* beetle when the latter is egg laying in the trees.

Protection and Remedies.

Once the life history of this beetle is well understood the introduction of certain measures to check its further increase on a large scale becomes possible. It is obvious that any measures which will result in the killing off of the grubs before they change to pupæ and beetles will result in the disappearance of the insect from the area as a pest since there will be no further egg-laying on a large scale. Our present knowledge of the life history enables us to cope with the pest in this manner. I have shown already that 4 full generations and a partial 5th may be expected this year in the Simla Catchment Area, if the dry spring at present being experienced is followed by normal rains and a normal autumn season.



1. Young deodar sapling dying under the effects of the attack of *Scolytus minor* (portions of the bark have been removed, showing the larval galleries beneath).
2. Same as 1; the lower larval galleries are those of *Scolytus major*.
3. Upper portion of a young deodar pole. The sap-wood is entirely covered with the galleries of the two *Scolytus beetles*, the bast layer having been totally destroyed and the tree killed. *a*, entrance hole; *b*, egg-gallery; *l*, larval gallery; *p*, pupating chamber.

I have also given the approximate periods at which the larvæ of each generation will become full grown. In order to deal with the attack which now threatens to assume serious proportions in the Simla Catchment Area it will be necessary to take steps to destroy the larvæ of each generation as it appears.

The beetles are at present attacking trees in three stages:—

(a) Newly felled or fallen green trees.
(b) Standing sickly trees.
(c) Standing green trees in the neighbourhood of a "centre" of infection.

Accordingly the first step to be taken is to mark down all infested trees whether felled or fallen, standing sickly or standing healthy trees.

(a) *Newly felled or fallen trees.*—The first of these are known and can be easily marked down. The second should be searched for and marked down. This will involve going over the whole area carefully.

(b) *Standing sickly trees.*—Many of these have been already noted. Some are just dying or dead as a result of a bad attack upon them by the last generation or two of last year. The beetles from these trees have mostly escaped and are now (April) engaged in laying the eggs of the first generation of the year in other trees. The whole area must be gone over and all trees found should be noted and marked with a tar ring. It is not to be expected that the whole of these trees will have been found in time to catch the first generation of the beetle which will issue about the third week in May. If the first is not caught it should be possible to mark them all down in time to catch the larvæ of the second or third generations.

In the case of (a) and (b) the stems or trees will be left in the forest until about the 1st week in May, (b) should then be felled and (a) and (b) barked and the bark turned up so as to expose it to the rays of the sun. This will be strong enough to kill off the larvæ. All saplings or branches which are too thin to be barked should be burnt. If however (b) are not badly infested with the beetle they should be left standing to serve as trap trees for succeeding generations.

(c) *Standing green infested trees.*—Instances exist in this forest where green healthy trees immediately adjoining trees attacked by the last generation of last year are now being infested by the beetles of this last generation. Last year's infested trees are either dying or just dead as evidenced by the majority of the needles left on the trees having turned yellow whilst many have already dropped. It will be found that these newly attacked green trees are much more difficult to deal with, as their removal must depend entirely on the degree in which they are attacked and on their nearness or otherwise to "centres" of infection. It will also be found very difficult to discover them until they are commencing to fade. It may prove advisable to leave those discovered early standing over one, two, or even three generations of the insect since there is a likelihood of their serving as an attraction to further beetles to lay their eggs in. They thus serve as "traps" and if used as such properly they may attract a large number of beetles which would otherwise oviposit elsewhere in uninfested trees. In all cases where such trees are not very seriously attacked I would recommend that they be not felled before the larvæ of the *second* generation of the beetle are reaching full growth, *i.e.*, about the end of June. They will thus serve the purpose throughout the area of "trap trees."

Trap Trees.—In order to ascertain the extent and intensity of the present attack I recommend that suitable green trees be chosen here and there in the forest, preferably along a road or footpath, and felled. These trees should be felled just before the periods at which the *beetles* are to be expected on the wing in the forest. It will be found that the beetles will resort to these felled trees which will thus serve as "traps." As soon as they are full of fully grown larvæ they should be barked and the bark exposed to the sun or burnt, as may be deemed most advisable. If a trap tree is not seriously infested by the generation of beetles issuing soon after it has been felled it may be left for a following one. The trees should be so felled as to lie in a position sheltered from the sun during the hottest portion of the day. In choosing these trees it must be borne in mind that they must be healthy and full of sap. It will be useless felling nearly dead trees for such a purpose as they would rapidly dry and would not be sought out by the beetle. The beetles require fresh sappy cambium to lay their eggs in.

To recapitulate:—

The periods to fell trap trees are as follows:—

1st generation	1st week in April.
2nd „	4th „ „ May.
3rd „	2nd „ „ July.
4th „	4th „ „ August.
5th „	2nd „ „ October.

The periods to fell and bark sickly trees containing full grown larvæ, to bark fallen or trap trees, and expose bark to sun or burn it, are as follows:—

1st generation	2nd week in May.
2nd „	End of June.
3rd „	2nd week in August.
4th „	4th „ „ September.
5th „	2nd „ „ November.

THE BLUE PINE POLYGRAPHUS BARK-BORER.

(*Polygraphus major*, Steb.)

Vernacular names:—*Unknown.*

References:—*Departmental Notes, Vol. I, pp. 234-238.*

Nature of Attack.

The male beetle bores through the bark of the blue pine—(or deodar) and eats out a pairing chamber in the bast and sap wood. Three female beetles successively enter the pairing chamber by the male entrance hole in the bark and after pairing bore away from the central chamber in different directions. The galleries so made are the egg galleries, eggs being deposited on either side of them; the larvæ on hatching out bore away from the egg gallery in a direction more or less at right angles to it. When sufficiently numerous the beetles and their larvæ remove all the bast layer and the tree dies.

Distribution.

The distribution of this insect is similar to that of the deodar *Scolytus major* and *Scolytus minor.*

General appearance.

Egg.—The *egg* is a tiny round translucent globule very like the egg of *Scolytus.*

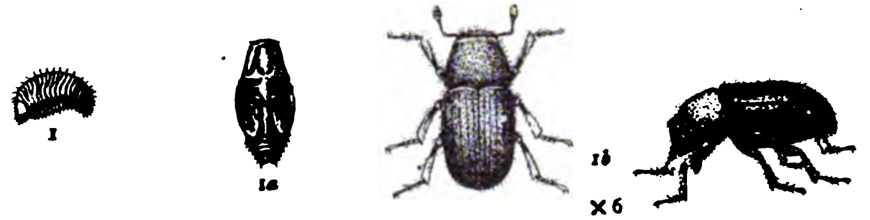
Grub or *Larva.*—Resembles to some extent that of *Scolytus.* It is a white curved legless grub largest at the head end and about ⅛th inch in length when full grown. When newly hatched it is a minute yellowish white dot. (Pl. IV., fig. 1.)

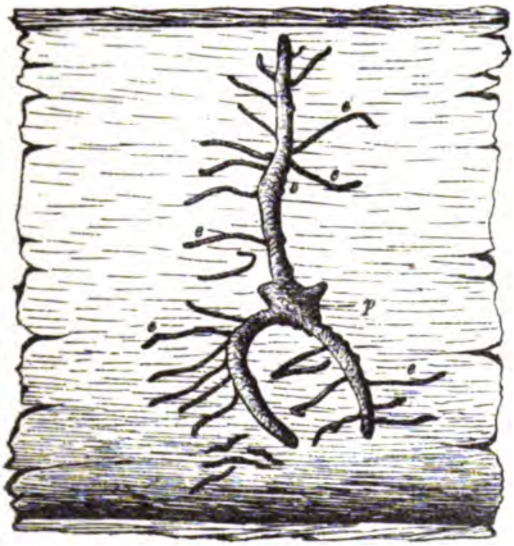
Pupa.—The *pupa* is whitish-yellow and of the ordinary beetle type. See fig. 1a, Plate IV.

Beetle.—The *beetle* is elongate, oblong and hairy and narrowed in front. When found in the pupal chamber in the sap wood it is bright yellowish brown in colour; before emerging it darkens in colour. The head and thorax (front part of insect) are black and shining and sparsely covered with hair, the elytra (back upper part of insect) are chestnut brown in colour and covered with yellowish hairs. These hairs are at times greyish giving a greyish appearance to the whole insect. The thorax is pitted all over and the elytra have fine longitudinal channels and pits on them. The under surface is black and shining and flat behind, not projected upwards as is the case with the *Scolytus* beetle. Length ⅛th inch. Plate IV, fig. 1b, shows the beetle.

Life History.

The life history of this beetle so far as its appearance in the forest goes is somewhat similar to that of the *Scolytus* beetles described above. It differs however in certain important particulars, the chief of which is the fact that the insect is a polygamous one and pairs with more than one female, the number being most usually three. The insect appears to pass through the





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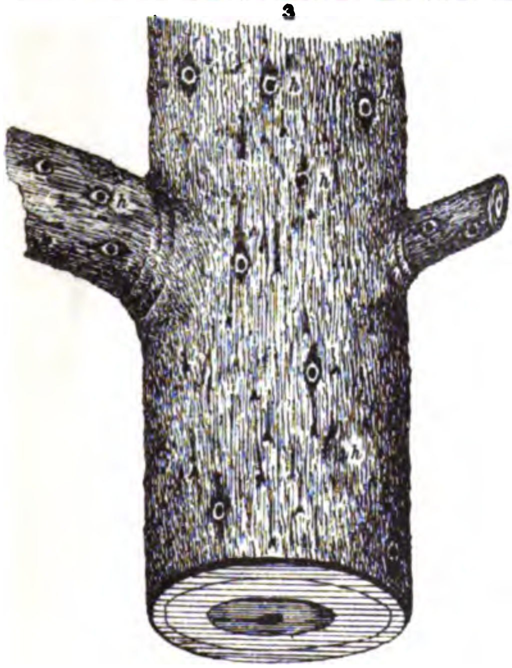

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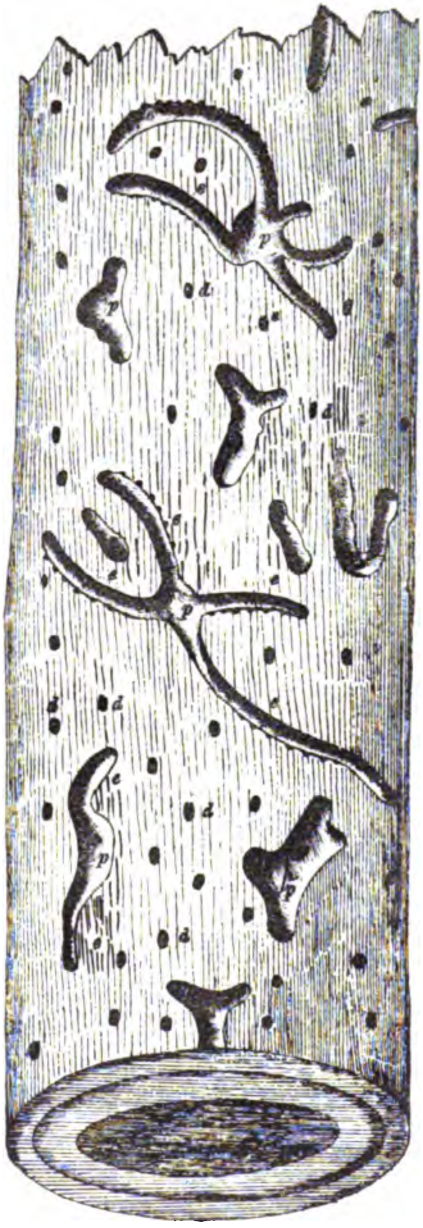

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1. *Polygraphus major*; 1, larva; 1a, pupa; 1b, back and side view of beetle.
2. Portion of blue pine stem showing entrance holes (*h*) of beetles in bark.
3. Inner surface of blue pine bark showing pairing chamber (*p*); three egg galleries (*e*), and larval galleries (*l*).
4. Blue pine sapling showing pairing chamber (*p*), egg galleries (*e*), and pupal chambers (*d*) in sap-wood.

winter in a similar manner to the *Scolytus* beetles described above, *i.e.*, either as a mature beetle (its place of hibernation is however unknown) or as an overwintering larva. As is the case with the *Scolytus* if the larvæ have already changed to pupæ when the first cold snap sets in they will probably be killed by it as bark beetle-pupæ easily succumb to frost. The overwintering beetles commenced laying the eggs of the first generation of the year at the beginning of April in 1908 (in the Simla Catchment Area), which was about a week earlier than its companion the *Scolytus* and from 3-4 weeks earlier than is usual in ordinary years. The tree chiefly preferred by the beetle is the Blue pine (*Kail*). The male beetle bores its way through the bark down to the bast layer and gnaws out in this and the sap wood a chamber of irregular stellate shape (Plate IV, fig. 3p). The male beetle chooses for this operation any part of the stem or branch of the tree which is soft and succulent. It never bores in through thick old bark. In the case of branches the only desideratum is that there should be some wood in them. Through the tunnel made by the male, usually three, but occasionally 4 or even 5, female beetles successively enter and after pairing with the male proceed to excavate their egg galleries. Each beetle constructs one such gallery (*e*) and each takes a different direction to that taken by the others. In this way the egg gallery plans shown in figs. 3, 4 are produced. These egg galleries are bored deep in the bast and sap wood; they are usually curved and from 1 inch to 1½ inches in length. The female, as she bores out her tunnel, gnaws out little notches at the side and places an egg in each. These notches are not made so symmetrically as in the case of the *Scolytus* beetle, there being usually more on one side than on the other. From 8 to 15 eggs appear to be laid in each gallery (see fig. 3). The first eggs hatch out before the female beetle has finished egg laying which process takes from 4 to 6 days.

The larvæ on hatching out feed almost entirely in the bast and bark and rarely groove the bast wood.

They bore winding galleries in a direction approximately at right angles to the egg gallery, their tunnels averaging ¾ to 1 inch in length. These tunnels are closely packed with the wood excreta passed out by the larvæ in feeding (3*l*). When full fed at the end of about 4 weeks they eat out a small chamber in the sap wood (4*d*) at the end of the larval gallery and change to pupæ in this. When the pupa has matured into the beetle, in from 8 to 13 days, the latter bores its way out direct to the outside by a horizontal tunnel. Where the bark is of fair thickness the portion of the pupal chambers in the wood consists of merely a saucer-shaped depression in the wood. It is more usual, however, for the whole of the pupal chamber to be entirely hollowed out in the sap wood. From this method of feeding it will become apparent that whilst the whole of the plan of the egg galleries and larval galleries will be always visible in the bark (fig. 3) it is most usual to find on the sap wood a central chamber from which 3 or more arms take off and at some distance from these arms irregular rows of small holes in the wood—the pupating chambers of the grubs whose tunnels were made entirely in the bast layer and are therefore not visible in the sap wood (fig. 4). This is the most characteristic appearance of stems and branches attacked by this pest and by it the presence in the forest of the insect is easily recognisable. Unlike the *Scolytus* the egg gallery of this beetle is loosely packed with the wood particles eaten out in excavating it. When she has finished egg laying she bores a short off-shoot gallery off the egg gallery in which she dies; or she may die at the top of a prolongation of the egg gallery, no eggs being laid in this portion.

In small branches the beetle grooves the sap wood much more deeply and the egg galleries are usually much longer than in thicker ones.

When attacking the deodar the number of egg galleries taking off from the pairing chamber appears to be usually two or at most three.

It has been said that the insect principally attacks the blue pine. It also infests the spruce to some extent and more seriously the deodar in areas where the *Kail* is scarce. When infesting the deodar the periods occupied in passing through the several generations of the year appear to coincide more or less exactly with those of the *Scolytus*. The bark and wood of the tree being harder than the *Kail* it finds it more difficult to work in and its egg and larval galleries are shorter.

The insect would seem to pass through about 4 (the 4th a partial one) generations under ordinary conditions. In a dry year such as the present we have seen that it commenced egg laying operations at the beginning of April and that it takes about six weeks to pass through a generation. The following generations (for the *Kail*) may therefore be expected in the Catchment Area (the actual periods of the appearance of the various stages of the insect being more or less approximate but sufficiently accurate for working purposes):—

Generation I.

Beginning of April	EGGS.
1st week April to 1st week May	Larvæ.
„ „ May „ 3rd „ „	Pupæ.
2nd „ „ „ end of month	BEETLES.

Generation II.

3rd week in May	EGGS.
„ „ „ „ to 3rd week in June	Larvæ.
„ „ „ June to 1st „ „ July	Pupæ.
End of June to middle of July	BEETLES.

Generation III.

1st week in July	EGGS.
„ „ „ „ to 1st week August	Larvæ.
„ „ „ August to 3rd week in August	Pupæ.
Middle of August to end of month	BEETLES.

Generation IV.

3rd week of August	EGGS.
„ „ „ „ to 3rd week in September	Larvæ.
„ „ in September to 1st week in October	Pupæ.
End of September to middle of October	BEETLES.

Generation V. (A partial generation.)

1st week in October	EGGS.
„ „ „ „ to 3rd week in November (Some of these larvæ will probably be overwintering larvæ.)	Larvæ.
„ week in November to 3rd week in November	Pupæ.
Middle of November (These beetles will hibernate through the winter months.)	BEETLES.

These generations will depend upon climatic conditions but the favourable and early start the insect has made practically assures the appearance of at least 4 generations.

Damage Committed in the Forest.

This insect confines its attacks to young growth only, infesting trees which have not as yet put on an outer layer of old dead bark. Owing to its polygamous habits it is capable of an even greater rapidity in increase than the *Scolytus,* once conditions are favourable to it. For egg laying purposes it undoubtedly has a preference for the blue pine and next to the blue pine the spruce. It has been shown however that when these trees are scarce in a forest and the beetle is abundant it will oviposit in deodar and this characteristic of the beetle renders it a much more dangerous pest than would otherwise be the case.

It is a more active beetle than the *Scolytus* and flies by day and tunnels into trees in broad daylight and even in sunlight. It is not so sensitive to sunlight as its companion and will tunnel into a tree or branch on almost any side. Poles, saplings and quite young growth are alike infested and it will tunnel into healthy green standing trees in the forest. The beetle appears endowed with a strong vitality, for it will be almost invariably found in some stage of its existence in felled green trees and green branch wood of the trees it affects and is not so susceptible to their rapid drying as is the *Scolytus.* It spreads in a forest in a similar manner to the *Scolytus* beetles.

Natural Enemies.

Both *Thanasimus himalayensis* and *Niponius canalicollis,* the two predaceous beetles already described as feeding upon the *Scolytus* beetles, prey upon the *Polygraphus major* beetle in a similar manner, whilst their larvæ feed upon the bark-borer grubs in the tunnels in a similar fashion.

Protection and Remedies.

The measures to be taken to combat the attack of the blue pine borer are similar to those already laid down for the deodar bark-borer.

The blue pine insect however only attacks poles and saplings and will not be found to infest poles whose bark has attained a thickness which results in an outer layer or covering of old dead bark being present on the tree.

The insect requires for egg laying purposes soft sappy bark. Consequently small poles may be felled as trap trees but they must be green. The fact that they dry fairly quickly does not appear to inconvenience the insect once the larvæ have become half to two-thirds grown. An inspection will show that the beetles now in the forest on the Catchment Area have oviposited in all the tops and small saplings cut over in the felling operations in the Coppice Working Circle. In fact wherever a green felled blue pine sapling or pole or green branch wood have been met with in the forest they have always been found to be full of the beetle engaged in its egg laying operations.

The serious aspect of this beetle's presence is due to the fact that owing to the scarcity of blue pine on the area it is attacking the deodar. A notable instance is to be found in the case of "Centre 8". Here a group of small deodar saplings were attacked and killed by the *Scolytus* beetle last year. Close by there is another group of small deodar saplings green and healthy to all appearance. An inspection has shown that they are partially attacked by *Polygraphus major*, a generation of which is just leaving the trees. Some of this generation is boring into the unaffected portions of these trees, others into a larger pole hard by.

I consider that the fact that this beetle is attacking the deodar instead of its own natural food is a most serious aspect of the present attack, as it would seem to indicate that the *Polygraphus* must be present in the forest in considerable numbers.

THE DEODAR BUPRESTID BEETLE.

(*Chrysobothris* sp.)

Vernacular name :—Unknown.
Reference :—*Departmental Notes, Vol. 1, p. 49.*

Nature of Attack.

The egg is probably laid on the bark in a crevice or depression. The grub on hatching out bores down to the bast and eats out in it and the sap wood an irregular winding gallery. When numerous these galleries coalesce and girdle the tree and the tree dies.

Distribution.

I took the larvæ of this insect in deodar in Bushahr in 1901 and have seen it since in Jaunsar. It is abundant in the Simla Catchment Area Forests. I have no other locality record at present but it is probably distributed throughout the Deodar tracts of the Western Himalaya. The only specimen taken of the beetle, whose grubs are probably the ones responsible for this damage to the deodar, was discovered by Mr. A. V. Munro dead in a pupal chamber in the Simla Catchment Area.

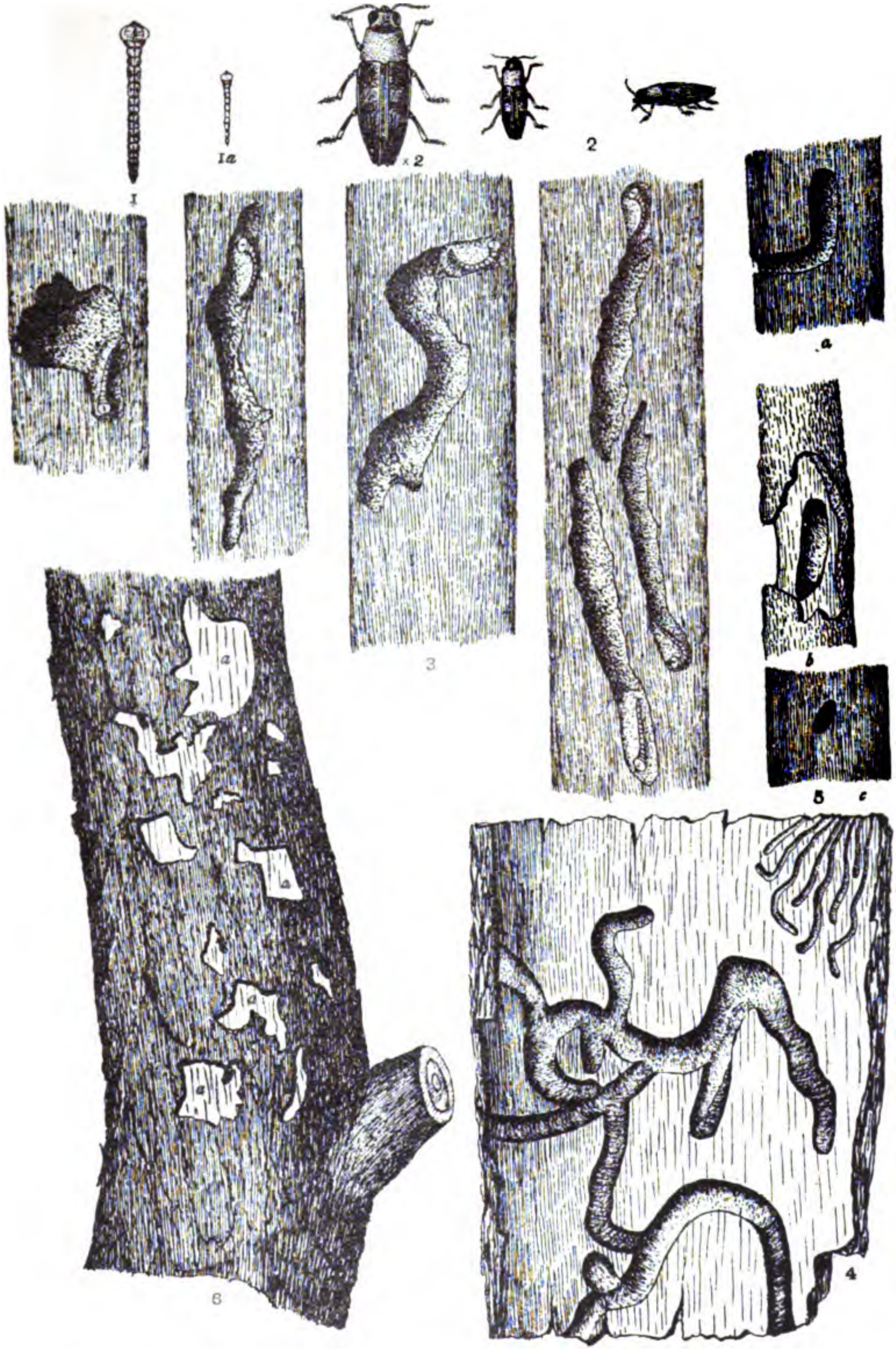
General Appearance.

Grub or *Larva.*—The *larva* is yellowish, flat, elongate and narrow with a large round segment immediately following the small yellow head; the segments following this large prothoracic segment, as it is called, are very much narrower in width and are more or less equal to one another in size. Its length is about 1 inch and it is usually found in its gallery with its lower segments curved round so as to lie against the ones above them. Plate V, fig. 1, shows the larva ⅔rds grown and 1a, a small one.

Beetle.—The *beetle* is elongate, cylindrical and dark greenish black in colour. The thorax is squarish with a coppery sheen on it; the wing cases or elytra are constricted towards the apex and rounded on sides; the apex ends in three teeth of which the middle one is the largest and the inner one very small; the surface of elytra is pitted and there are several prominent elevated lines or ridges upon them, the one prolonged into the median tooth being the most prominent. The under surface is lighter in colour. Length about ½ an inch. Fig. 2 shows the beetle natural size and enlarged.

Life History.

But little is at present known on the subject of the life history of this beetle. The few facts ascertained have been gleaned chiefly from the record it leaves behind it in the trees it attacks and from the few larvæ which have been taken from their galleries in living trees. The record left in attack trees gives us the following data. The egg is laid by the female either on the bark or down on the



1. *Chrysobothris sp.* The Deodar Buprestid beetle ; 1, 1*a*, larvæ.
2. Beetle, back (nat. size and enlarged) and side view.
3. Young larval galleries in bast layer and sap-wood of tree with larvæ *in situ*.
4. Larval galleries in bark of deodar.
5. 5*a*, 5*b*, pupal chambers in sap-wood ; 5*c*, entrance tunnel in sap-wood (section).
6. Base of deodar sapling showing the characteristic appearance of trees attacked by the Buprestid ; the white patches *a*, *a*, are patches of sap-wood from which the bark

outer surface of the bast since the young larval gallery appears to commence here. The grub feeds in the bast at first and as it gets larger goes deeper and grooves both the outer bark and the sap wood. This gallery has no definite direction. Sometimes it is carried up the tree, at others down or across, especially when the larva is young, see fig. 3. It curves about, the total length being from 2 to 2½ inches and breadth at its widest part about ⅙th to ¼ inch (fig. 4). When the grub is full grown it bores down into the sap wood at an angle for about ½ an inch and then eats out a pupal chamber in the wood somewhat larger than the size of the future beetle (fig. 5 a, b); the section of the entrance tunnel in the wood is narrow ellipitcal (fig. 5c) and the presence of these entrance tunnels in the sap wood is very characteristic of the beetle and are clearly visible when the decayed bark above has fallen off in patches (fig. 6). The larva changes to a pupa in the pupal chamber and the beetle, on maturing, crawls out of the tunnel, eats its way through the bark if it has not fallen off already, and escapes from the tree. A characteristic feature of their attack is shown in fig. 6. The bark covering the larval galleries beneath apparently rapidly decays and falls off and thus an attacked tree shows at the spots infested irregular shaped areas of the whitish yellow sap wood from which the dead bark has dropped off. This feature is always present and enables attacked trees to be readily recognised.

When the eggs are laid, how long the larvæ take to reach full size, the time of appearance of the beetle and the number of generations passed through in the year have yet to be ascertained.

Damage Committed in the Forest.

The damage committed by this insect, when numerous, in a forest is very serious. The larvæ require absolutely fresh green bast and therefore the eggs are always laid in green, and apparently green standing, trees.

The irregular method of feeding of the grubs renders the insect more destructive than would ordinarily be the case as they girdle a tree much more rapidly, even when but a moderate number of insects are present than is ordinarily the case with bark-borers. Instances have seen seen where trees, only attacked at the base, have been ringed by a comparatively few lavas and so killed. Within the limits defined by their several life histories bark-borers of the

Scolytus type go into a tree anywhere and thus require to be unusually abundant before their operations ring and kill a tree.

The Buprestid attacks trees of all sizes but it has perhaps been found to be most abundant in the Catchment Area in snow bent and broken green saplings of which there are a number in the forest.

A characteristic of this insect appears to be that it always attacks the trees on the sunny side, *i.e.*, the *Southern:* if the tree is bent over, as are the snow breaks, it invariably attacks it on the *upper* side. This is in exact opposition to the habits of the bark-boring insects which always attack on the *Northern* or, in the case of bent or felled trees, on the *under* side. This habit renders the two pests, when working together as they have been in the Catchment Area, more deadly, as they kill the trees quicker.

Natural Enemies.

I have taken from one of the pupal chambers of this insect a number of small hymenopterous flies still enwrapped in their silky cocoon covering. These are probably parasitic and their grubs may parasitise those of the Buprestid. It is too early however to say anything further about their habits.

Protection and Remedies.

Until a working knowledge of the life history has been ascertained it is not possible to state what will be the most effective means to introduce to combat the attacks of this pest. If it turns out that it passes through a number of distinctly defined generations in the year it should be possible to employ the methods applicable to the *Scolytus* and *Polygraphus* beetles. It is possible however that its generations overlap each other and some countenance is given to this supposition by the fact that larvæ of apparently nearly full growth and quite small ones were found together in the same tree in the Catchment Area on April 9th. Should this prove to be the case the matter will become more difficult.

I suggest that for the present the area in the Coppice Circle badly attacked last year be closely watched and the appearance of the insect at work in it be at once reported and careful notes made on its appearance and mode of attack.

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COMPILED BY

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INTRODUCTION.

THIS list of Forest Technical Terms has been compiled in the hope that many of them will be brought into use at once and so help to provide a desirable uniformity in the definitions used in professional literature, for it seems certain that such literature will, in the future much more largely than in the past, influence the progress of Indian Forestry. It is not claimed that the list is complete or that the definitions are in all cases satisfactory. The author will be glad to receive any suggestions which may facilitate the issue of an improved 2nd Edition.

S. EARDLEY-WILMOT,

Inspector General of Forests.

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A GLOSSARY OF TECHNICAL TERMS FOR USE IN INDIAN FORESTRY.

Abnormal forest. A forest in which the quantity of material in the growing stock is insufficient or superabundant; or in which the proportion between the age classes is defective.

See Normal forest.

Absolute form factor. *See* Form factor.

Accessory produce. That material which is of secondary importance as regards the management of a forest.

Accessory species. A species of inferior quality or size, of little value or importance.

Acid humus. Humus which is too wet and insufficiently aerated, thus obstructing rather than aiding the growth of forest vegetation.

Administration, Forest. *See* Forest administration.

Advance cutting or felling. *See* Preparatory felling.

Actual possibility. *See* Possibility, Actual or Present.

Advance growth. Young trees which have sprung up in openings in the forest or under the forest cover before reproduction cuttings are begun.

Adventitious buds. Those produced irregularly from any part of the stem, leaves, or roots.

Adventitious roots. Those produced otherwise than by direct prolongation of the radials of the embryo.

Afforest, to ; or Afforestation. (*i*) To establish a forest either by natural or artificial means.

(*ii*) To take proceedings under a Forest Act to have any land declared to be reserved forest.

Age. The age of a regular or even-aged crop is the mean age of the trees composing it. In a crop of mixed ages, the age of the class (of trees of the principal species) most numerously represented is generally taken and alluded to as the *predominant age.*

Age class. That portion of a crop which is approximately of one age.

Age classification. The division of a crop according to differences in the age.

Age, Exploitable. The age when the main crop in a forest has attained the condition that is required in order to fulfil the purpose for which it is worked. The exploitable age also expresses the time required by the new growth in a crop which is being generated to attain that condition.

See Rotation.

Age gradations. A series or part of a series of trees or crops ranging from the seedling to the mature tree.

Aged, Even. When the crop is approximately all of one age class. *See* Crop.

Aged, Uneven. When the crop is of many different age classes. *See* Crop.

Alburnum trees. Without ascertained distinction between heartwood and sapwood.

Allotment of woods to the different periods of one rotation ; or Allotment into periodic blocks. The sub-division of a forest into blocks equal in number to the periods in the rotation, so that in each period one block may be treated by the method of successive regeneration fellings or in other ways.

Analysis, Stem. *See* Stem analysis.

Analysis, Tree. *See* Tree analysis.

Annual increment. The material produced on a tree, or a given area in one year. *See* Average annual increment; Current annual increment.

Annual ring. The layer of wood produced by the growth of one year, as seen in cross section.

Arborescent shrub. *See* Shrub, Arborescent.

Area, Basal. *See* Basal area.

Area, Catchment. *See* Catchment area.

Area, Cutting. *See* Coupe.

Area, Experimental. *See* Experimental area.

Area, Sample. *See* Sample area.

Artificial form factor. *See* Form factor.

Artificial regeneration. Regeneration obtained by sowings, plantings, or other artificial means. *See* Regeneration.

Artificial reproduction. The renewal of a forest by sowing or planting or other artificial means.

Aspect. The direction in which a forest faces.

Assessment of yield capacity; or Assessment of the quality of the locality. The determination by actual measurements of the quantity of material which a given area is capable of producing under normal conditions as long as the factors of the locality remain unchanged.

Auxiliary species. A useful species of less value than the principal species, which assists the growth of the latter and influences, in a smaller degree, the method of treatment.

Average annual increment. The total material in a tree or crop divided by its age in years.

Ball planting. Planting young trees with balls or lumps of earth around the roots.

Bark-blazer. An instrument used for marking trees by scoring the bark.

Basal area. The area of a cross section of the butt of a tree, or the sum of such areas.

Basket planting. Pricking out seedlings from the seed bed into loosely woven baskets.

Bearer, Seed. *See* Seed bearer.

Bearer, Shade. *See* Shaed bearer.

Beat. A protective territorial charge. A sub-division of a range. A Forest Guard's charge.

Bed, Germinating. *See* Germinating bed.

Bed, Seed. *See* Seed bed.

Belt, Protective. *See* Protective belt.

Blank. An unstocked area where, from any cause, few or no trees are growing.

Blaze, to. To mark standing trees selected for any purpose.

Blaze, Gum or Resin. *See* Resin blaze.

Blazer, Bark. *See* Bark-blazer.

Block. A natural main division of a forest, generally bearing a local proper name.

Block, Periodic. *See* Periodic block.

Bole. The trunk or stem of a tree from the ground to the point where its main branches are given off. The lower part of the bole, if free of any branches, is called the *clear bole.*

Books, Control. *See* Control books.

Borer, Increment. An instrument for extracting a cylinder of wood from the stem of a tree. Also known as " Pressler's Borer ".

Branch, Epicormic. *See* Epicormic branch.

Breasthigh. A height of 4½ feet above the ground.

Broadcast sowing. When seed is distributed over the whole area to be stocked.

Broad-leaved trees. A distinguishing term in distinction to conifers. Generally deciduous trees.

Broad-leaved wood. A wood composed of trees which are not conifers.

Brulé. An area over which fire has run to the noticeable injury of the forest.

Brushwood. A growth of low shrubs and bushes; used also to indicate the fallen or cut branches and twigs of trees.

Bud, Adventitious. *See* Adventitious bud.

Bud, Dormant or Latent. *See* Dormant bud.

Bush. Undershrubs, and every degraded condition of shrubs and trees, in which the plants consist of numerous low spreading branches, or fork out into a number of thin stems.

Calliper. An instrument for measuring the diameter of round timber.

Canopied forest. A forest composed of trees the crowns of which form a more or less continuous leaf cover. When the lateral branches of the trees constituting the crop touch one another without being shaken by the wind.

Canopy ; or Leaf Canopy. The mass of foliage formed by the crowns of a collection of trees in a forest.

Canopy, Close or Closed. *See* Close canopy.

Canopy, Dense. *See* Dense canopy.

Canopy density. The comparative impermeability to light of the mass of foliage formed by the crowns of the trees in a forest. The following degrees of density are recognised :—*Close canopy, Open canopy,* and *Interrupted canopy.* Or, *Closed canopy, Dense canopy, Thin canopy, Open canopy,* and *Park forest.*

Canopy, Interrupted. *See* Interrupted leaf canopy.

Canopy, Open. *See* Open canopy.

Canopy, Thin. *See* Thin canopy.

Capacity, Yield. *See* Yield capacity.

Capital, Forest. *See* Forest capital.

Catchment area. The total area from which aqueous precipitations flow into a given water-course.

Cattle. Includes elephants, camels, buffaloes, horses, mares, geldings, ponies, colts, fillies, mules, asses, pigs, rams, ewes, sheep, lambs, goats, and kids.

Charcoal kiln. *See* Kiln, Charcoal.

Check counting. A re-enumeration of the whole or part of the forest stock with a view to verifying the results of a previous counting.

Circle, Working. *See* Working circle.

Class, Age. *See* Age class.

Class, Diameter or Girth. *See* Diameter class.

Class, Form factor. *See* Form factor class.

Class, Height. *See* Height class.

Class, Locality. *See* Locality class.

Class, Tree. *See* Tree class.

Classification, Age. *See* Age classification.

Clean fell, to. *See* Clear fell.

Cleaning. The removal of inferior individuals or species from a crop, especially where these are interfering with the superior growth.

Clear, to. To remove all the material from off the ground.

Clear bole; or Clear trunk. *See* Bole.

Clear fell, to; or Clear felling. A complete removal of the standing crop. A clear felling may be in strips, in patches, or in compartments.

Clear felling, Method of; or Clearances, Method of. Removal, in one operation on a portion of the area to be treated, of the whole crop in such a manner as to pass over the entire area once during the period that is fixed for trees of the species felled to attain the exploitable size. This method includes several different forms, *viz.*,

- (*i*) Clearings on small areas with natural regeneration, or the *Patch Method.*
- (*ii*) Clearings on alternate parallel strips, or the *Strip Method.*
- (*iii*) Clear fellings with artificial regeneration, or the *Compartment Method.*

See also System of high forest with reserves.

Clear length. That portion of the bole of a tree which is free from branches. *See* Bole.

Climber. General term including climbing, twining and creeping plants. Plants that ascend upon a support by twining, or by means of tendrils or hooks or aerial roots or other attachments.

Close, to. To prohibit entry into a forest for the purpose of exercising any definite act such as firing, grazing, felling, shooting, removal of grass and minor products, etc.

Close or Closed Canopy. When the branches or crowns of the trees interlace, or at least touch one another, without being shaken by the wind. When the cover formed is uninterrupted and the ground is shaded

Close crop. A crop which is completely stocked so that the crowns of the trees interlace and form an uninterrupted leaf canopy which thoroughly shelters the ground. *See* Crop.

Close felling. *See* Dark felling.

Close time. The period during which a forest is closed, or game is protected.

Closed forest. A forest to which entry is prohibited for the purpose of exercising any definite act. *See* Close, to.

Clump. The aggregate of stems issuing from the same root or stool. Or, the collection of culms composing an individual bamboo plant.

Commutation of rights. The payment of compensation in cash or kind in lieu of rights claimed in a forest.

Compartment. A sub-division of a block, as far as possible homogeneous as regards soil, composition, and age of the crop; or which can be described as a unit for working-plan purposes.

Compartment line. The boundary of a compartment.

Compartment system. *See* Method of successive regeneration fellings.

Compass, Tree. *See* Tree compass.

Complete crop. The maximum quantity of material which a given plot can bear at a given age. In every case a crop is, as regards its density, either *complete* or *incomplete.* It is *complete* when it presents a density conformable to its nature and age, where this is not the case it is *incomplete.* *See* Crop.

Complete enumeration survey. When the material constituting the growing stock is ascertained by counting or measuring all the trees over the whole area. *See* Enumeration survey.

Composition. The various species which form the crop, their proportion and condition.

Conifer. An evergreen tree which usually bears needle-like leaves.

Conservancy, Fire. *See* Fire conservancy.

Constitution. The presence of the different age-classes in a crop and their distribution.

Control books. Registers compiled with a view to recording the treatment to which forests have been subjected in accordance with the prescriptions of regular working-plans, and the results of such treatment.

Conversion; or Convert, to. The application of a new method of treatment involving a change in the manner by which reproduction is obtained.

Conversion period. The period during which the change from one system of forest management to another is effected.

Conversion of timber. The work of dividing felled trees into pieces of dimensions suitable for utilization.

Coppice; or Coppice forest. A crop mainly composed of trees derived from stool or root-shoots.

Coppice, to. Possessing the power of sending up root or stool-shoots when cut flush with or close to the ground.

Coppice, to (act). To cut trees flush with or close to the ground with a view to reproduction by root or stool-shoots.

Coppice felling. A removal of the whole of the forest crop with a view to regeneration from the shoots and suckers of the stems felled.

Coppice shoot. A stem which has sprung from a stump or root and not from seed.

Coppice system, Simple. The formation by means of stool and root-shoots of a forest crop which is periodically removed by clear felling. The regeneration fellings in this method are called *coppice* fellings.

Coppice with standards. A two-storeyed forest in which coppice shoots form the lower, and selected coppice shoots or seedling trees, the upper storey.

Coppice with standards system. Similar to the coppice system save that a certain number of the most promising and valuable stems are reserved at each felling and suffered to attain a larger size than the rest of the coppice growth. The regeneration fellings in this method are called *stored* or *mixed coppice fellings,* or *standard fellings* when they relate solely to the trees reserved.

Cost value. The total outlay on the acquisition or production of a property.

Counterfire. A fire started purposely some distance from a forest fire with the object that both may be extinguished when they meet.

Counting, Check. *See* Check counting.

Coupe. The area set aside to be felled over in a single year or period.

Cover; or Covering. The term " cover " is used to express the horizontal projection of the crown on the ground and is applied both to the ground so covered and also to the action of the cover. *See* Interrupt the cover.

Cover, Ground or Low. The shade afforded by small plants not being a portion of the forest crop, such as ferns, mosses, grasses and weeds.

Cover, Surface or Soil. *See* Surface cover.

Creeper. Plants with stems which extend their growth horizontally. A frequent misnomer for climber.

Crop. The entire collection of trees growing on a given area. The terms *stock, growing stock, tree-growth* and *crop* are synonymous. A crop may be *complete* or *incomplete* (*interrupted*), *pure* or *mixed, even-aged, or uneven-aged*; and it may be described as *crowded, close, dense, open* or *thin.*

Forest crops are sometimes classified as follows in terms of their stages of development :—

Seedlings.—From the germination of the seeds to the time when the newly developed branches meet.

Thicket.—From the time of the branches meeting to the fall of the lower branches.

Poles.—From the fall of the lower branches to the time when the crop attains its full height.

Trees.— From the time of the stems having attained their full height.

See Canopy density.

Crop, Crowded. *See* Crowded crop.

Crop density. The degree of completeness of the leaf canopy of the trees. This is usually expressed by a co-efficient: but may be described by stating the species, the number of stems and their age per unit of area.

Crop, Interrupted. *See* Interrupted crop.

Crops, Irregular. *See* Irregular crops.

Crop, Nurse. *See* Nurse crop.

Crop, Seedling. *See* Seedling crop.

Crop, Uniform. *See* Uniform crop.

Crowded crop or wood. A crop or wood which is so completely stocked that the crowns of the trees interlace and form an uninterrupted leaf canopy which completely shelters the ground.

Crown. The collection of main branches overtopping the bole. In an even-aged forest crop the following crown classes are recognised :—

Predominant : trees with an exceptionally vigorous crown.
Dominant : trees with a well-developed crown.
Slightly dominant : trees with a poorly developed crown.
Slightly suppressed : trees with an incomplete crown.
Totally suppressed : trees with the crown wholly below the level of the dominant trees.

The first three classes of dominant trees form the *major or primary part of the growing stock* : the last two classes form the *minor or secondary part of wood or intermediate yield.*

Crown fire. A forest fire which spreads to the crowns of the trees. *See* Forest fire.

Culm. The leafy shoot or aerial stem sent up from the rhizome or underground stem of a bamboo.

Cultural operations. Operations undertaken with the object of filling up blanks in forests, such as the sowing or planting of areas where natural reproduction of the desired species is unlikely or impossible.

Cupshakes. Faults in timber due to meteorological causes, such as violent winds, excessive cold, frosts, sudden changes of temperature, sun-stroke.

Current annual increment. (Applied to height, girth, basal area, volume). The increase in height, girth, basal area, or volume added in a given year by the growth of a tree or crop.

Cut back, to. The operation of cutting flush with the ground or stool any stem, younger than a formed tree, with the object of obtaining superior growth by coppice regeneration.

Cutch or Teak taungya. The sowing of the seed of cutch (*Acacia Catechu*) or teak with that of field crops in forest areas which have been cleared and burnt over.

Cutting area. *See* Coupe.

Cycle, Felling. *See* Felling rotation.

Dark or Close felling. The removal of a few stems of a crop, so that the branches and crowns of the trees left standing will still touch one another when shaken by the wind. *See* Open felling.

Deciduous. A broad-leaved tree, which is leafless for some time during each year.

Deciduous forest. A crop composed of deciduous trees.

Defoliate, to; or Defoliation. The shedding or loss of leaves owing to either natural or abnormal causes.

Deforestation. 1. To disestablish a forest by conversion into other land.
2. To take proceedings under a Forest Act to have land declared as ceasing to be a reserved forest.

Delicate species. Species which sequire to be sheltered against injurious influences during their early years.

Demarcation. The act of setting out or marking the limits or boundaries of a forest.

Dendrology. The natural history of trees.

Dendrometer. An instrument for measuring trees.

Dense. A term applied to a crop which is so fully stocked that the crowns of the trees interlace and form an uninterrupted leaf canopy which completely shelters the ground. *See* Crop.

Dense canopy. When three-fourths or more of the ground is shaded.

Density of canopy. *See* Canopy density.

Density of crop. The degree of completeness of the leaf canopy of the trees that compose it. This is usually expressed by a co-efficient, but may be described by stating the species, the number of stems and their age per unit of area.

Denudation. Divesting the soil of its vegetative covering.

Depôt. A site on which forest produce is collected.

Determination of the yield; or Fixing the possibility. The calculation or determination of the maximum quantity of material which may, for the time being, be annually removed from a forest consistently with such treatment as shall tend to produce and maintain the greatest constant outturn.

Devil, Forest. *See* Forest devil.

Diameter breasthigh. The diameter of a tree at 4½ feet above the ground.

Diameter or Girth class. That portion of a crop which is approximately of one diameter or girth.

Diameter or Girth increment. The increase in diameter or girth of a tree due to growth.

Diameter gauge. *See* Calliper.

Diameter or Girth limit. The diameter or girth measured at a given height which defines the class in which trees are to be included for any given purpose.

Diameter or Girth, Mid. *See* Mid-diameter; or Mid-girth.

Dibble, to. To sow seed at intervals in holes.

Direct sowing. The formation of a wood by the sowing of seed directly on the area which it is proposed to stock.

Dominant. A tree which has raised its crown above the level of the surrounding trees. *See* Crown.

Dominated. A tree of which the crown is overtopped by the surrounding trees.

Dormant or Latent buds. Buds which remain quiescent, showing vitality only under specially stimulating conditions.

Draudt's method of sample trees. A modification of the general method of selecting and measuring sample trees in carrying out enumeration surveys.

Driftwood. All timber adrift, beached, stranded, sunk or otherwise apparently ownerless or out of control within a waterway or within fixed limits on either side thereof.

Dry-topped. Having a dead or partially defoliated crown, as the result of injury or disease. *See* Stagheaded.

Dunes. Areas of drifting sand forming, by the action of wind, moving hills of considerable height.

Easement. *See* Servitude.

Enumeration survey. The counting and classification of one or more species constituting the growing stock. An enumeration survey may be *partial* or *complete:* a partial enumeration survey may be carried out in separate (sample) *plots,* or in *strips* or *lines* (linear survey).

Epicorm; or Epicormic branch. A term applied to those clusters of small branches which make their appearance on the stem of a tree that has been exposed to adverse influences, such as excessive light or heat.

Epiphyte. A plant attached to, but not nourished by, another plant.

Even-aged crop. A crop of trees of approximately the same age.

Evergreen tree. A tree, the leaves of which persist at least for an entire year, so that it is never leafless.

Evergreen forest. A forest composed mainly of evergreen trees.

Examination, Preliminary. *See* Preliminary examination.

Exclusive species or tree. *See* Gregarious species.

Exotic. A plant, shrub, or tree introduced from another locality.

Expectation value. The present net value of all yields which a property may be able to give.

Experimental area or plot. A forest area of known size upon which investigations are carried out for the determination of the growth and behaviour of the growing stock, or to ascertain the effect of various methods of treatment.

Exploit, to. To work a forest for its material in accordance with the principles of sylviculture.

Exploitable. Material that has attained its maximum of usefulness for the owner of the forest.

Exploitable age. The age when the main crop in a forest has attained the condition that is required in order to fulfil the purpose for which it is grown. The exploitable age also expresses the time required by the new growth in a crop which is being generated to attain that condition. *See* Rotation.

Exploitability. The circumstance of material having attained its maximum of usefulness for the owner of the forest.

Exploitation. The operation of working a forest sylviculturally for its material.

Export line or road. A road or tract used for the purpose of extracting the material from a forest.

Factor, Form. *See* Form factor.

Factors of the locality. Local conditions influencing forest growth, such as elevation above mean sea level, soil, slope, aspect.

Faggot. A bundle composed of small branches of trees, usually used for fuel.

Faggot wood. Refuse crown, branch and coppice wood under 2½ inches in diameter at the larger end.

False ring. The layer of wood, less than a full season's growth, and seldom extending around the stem, which is formed when the diameter growth of a tree is interrupted and is resumed during the same growing season.

Fascine. A wood faggot used for a specific purpose, such as arresting the movement of sand, or holding up the soil.

Feeder, Surface. *See* Surface feeder.

Felling. 1. The act of cutting down one or more trees.
2. The area on which trees are being cut.

Fell, Clean or Clear. *See* Clear fell.

Felling, Advance. *See* Preparatory felling.

Felling, Clear. *See* Clear felling.

Felling, Close or Dark. *See* Dark or Close felling.

Felling, Coppice. *See* Coppice felling.

Felling cycle. *See* Felling rotation.

Felling, Final. *See* Method of successive regeneration fellings.

Felling, Improvement. *See* Improvement felling.

Felling, Open. *See* Open felling.

Felling, Order of. *See* Order of felling.

Felling period. *See* Felling rotation.

Felling, Preparatory. *See* Method of successive regeneration fellings.

Felling, Principal. *See* Principal felling.

Felling, Regeneration. *See* Regeneration felling.

Felling rotation. The time which elapses between two successive principal fellings on the same area. Also called *Felling period,* or *Felling cycle.*

Felling, Secondary. *See* Method of successive regeneration fellings.

Felling section. A sub-division of a felling series comprising a number of age gradations, the ages of which differ by a certain number of years. A certain number of felling sections together thus form one complete series of age gradations, or a felling series.

Felling, Seed. *See* Method of successive regeneration fellings, or Uniform Method.

Felling, Selection. *See* Selection felling.

Felling series. A Working Circle or a part thereof which forms a separate series of age classes.

Felling, Severance. *See* Severance felling.

Felling, Strip. *See* Method of clear fellings, or Clearances.

Felling, Systematic. *See* Systematic fellings.

Felling, Unregulated or Unclassed. *See* Unregulated fellings.

Final felling. *See* Method of successive regeneration fellings.

Final yield or outturn. Material derived from clear or regeneration fellings. Or, the return yielded by the final cutting of the wood, whether the old crop is removed in one cutting or by a number of successive cuttings.

Finance, Forest. *See* Forest finance.

Financial rotation. The rotation under which a forest yields, if calculated with a given percentage and compound interest, the highest net return.

Fire conservancy. The preservation and protection of forests from fire.

Fire, Crown. *See* Crown fire; Forest fire.

Fire, Forest. A fire which travels over forest land. A forest fire may be a *ground fire, a surface fire, a stem fire, a crown fire,* according as to whether the fire burns in the forest floor, or runs over the undergrowth, or ignites the stems or crowns of the trees.

Fireline or trace. A strip of land kept clear of inflammable material and used as a means of protection against the spread of forest fires.

Firepatrol or watcher. An officer employed to aid in Fire Conservancy.

Fire, Surface. A fire which burns the dead leaves, grass, and other soil covering of a forest. *See* Forest fire.

Firewood. 1. Wood for fuel.
2. Wood below a certain diameter or girth.

For statistical purposes, European Forest Research Institutes have agreed to take a girth of 2 decimeters (7·874 inches) as separating timber from firewood or small wood.

Fixing the possibility. *See* Determination of the yield.

Floatable timber. Timber which is lighter than water.

Floor, Forest. *See* Forest floor.

Flush with the ground. Close to, or level with, the soil; term applied to coppice fellings.

Fodder. Grasses and herbage, as well as the leaves and young shoots of trees and shrubs collected with the purpose of feeding cattle.

Forest. 1. An area which for the most part is set aside for the production of timber and other produce, or which is maintained in order to exercise climatic or protective influences on the adjacent country.

2. Any land which has been declared to be reserved forest by notification under a Forest Act.

Forest, Abnormal. *See* Abnormal forest; Normal forest.

Forest administration. The effective carrying out in detail of a Forest Policy.

Forest, Canopied. *See* Canopied forest.

Forest capital. The capital which a forest represents. It consists of the forest land, or fixed capital, and the growing stock or producing stock.

Forest, Closed. *See* Closed forest.

Forest, Coppice. *See* Coppice forest.

Forest crop. *See* Crop.

Forest, Deciduous. *See* Deciduous forest.

Forest denudation. Divesting the soil of its forest covering.

Forest depôt. *See* Depôt.

Forest devil. An implement for extracting stumps and roots.

Forest, Evergreen. *See* Evergreen forest.

Forest expectation value. *See* Expectation value.

Forest finance. The determination and regulation of the value of the forest soil or of the growing stock, or of the forest as a whole, and of the rental derivable from either.

Forest fire. A fire which travels over forest land. A forest fire may be a *ground fire, a surface fire, a stem fire, a crown fire,* according as to whether the fire burns in the present floor, or runs over the undergrowth, or ignites the stems or crowns of the trees.

Forest floor. The deposit of vegetable matter on the ground in a forest. Litter includes the upper, but slightly decomposed portion of the forest floor; humus the portion in which decomposition is well advanced.

Forest-grown. Produced in the forest from self-sown seed.

Forest guard. An officer in protective charge of a forest area or of forest works.

Forest, High. *See* High forest.

Forest humus. Organic matter of decomposed vegetable origin.

Forest, Indaing. *See* Indaing forest.

Forest, Irregular. *See* Irregular forest.

Forest in Storey, or Storeyed. A crop composed of stems of different ages, the crowns of which are arranged in tiers. *See* Storeyed forest method.

Forest management. The practical application to an area of the principles of forestry.

Forest, Mature. *See* Mature forest.

Forest mensuration. The determination of the dimensions, volume, age, and increment of single trees and whole woods, to permit of the calculation of the material standing on a given area, the yield which a wood can give, and the value of single trees, whole woods, and forests.

Forest, Mixed. *See* Mixed crop.

Forest Normal. A forest which corresponds in every way to the objects of management. The normal state of a forest under a given set of conditions depends chiefly on the presence in it of (*i*) a normal increment, (*ii*) a normal distribution of the age classes and (*iii*) a normal growing stock.

See Normal forest.

Forest nursery. An area upon which young trees are grown for forest planting. Nurseries may be either *permanent* or *temporary*.

Forest offence. Any act punishable under a Forest Act, or under any rules made under an Act.

Forest organization. The art of regulating the treatment and working of forests.

Forest pasture. The utilization of the herbage and grass of a forest by the admission of cattle.

Forest per cent ; or Indicating per cent. The percentage with which the capital, represented by a wood, works at various periods of the wood's life.

Forest plantation. Tree growth, established by sowing or planting in a defined area.

Forest police. Officers employed to prevent or detect forest offences.

Forest policy. The main principles which govern the administration of a forest in the best manner for the attainment of a specified object.

Forest, Private. *See* Private forest.

Forest privileges. Temporary and defined grants by the owner of the forest to individuals or communities of the use of a forest or of its produce. The grants may be given free or on payment.

Forest produce. *See* Forest Act, Chapter I, Section 2.

Forest products. All usable material yielded by the forest. Two classes are distinguished, *Major* and *Minor*.

Forest, Protected. *See* Forest Act, Chapter IV.

Forest protection. Ensuring the security of the forest against unfavourable influences.

Forest, Pure. A forest which consists of one species only.

Forest, Regular. *See* Regular crop or forest.

Forest, Riparian or Riverain. *See* Riparian or riverain forest.

Forest, Reserved. *See* Forest Act, Chapter II.

Forest right. *See* Servitude.

Forest, Seedling. *See* Seedling forest.

Forest, Semimature. *See* Semimature forest.

Forest settlement. The determination of the limits of a forest, and the definition of the servitudes imposed upon it.

Forest, State. *See* State forest.

Forest, Storeyed or in storeys. *See* Forest in storey.

Forest, Tidal. *See* Tidal forest.

Forest, Two-storeyed high. *See* Two-storeyed forest.

Forest utilization. The most appropriate method of harvesting, converting, and profitably disposing of forest produce.

Forest valuation. The determination of the value of the forest soil; the growing stock or the forest as a whole; and of the rental derivable from the soil or the forest as a whole.

Forest, Village. *See* Forest Act, Chapter III.

Forest, Virgin or Primæval. *See* Virgin forest.

Forestry. The science and art of making the best permanent use of the forest.

Forestry combined with the rearing of game. A forest which is primarily maintained as a game preserve. It may be worked under any of the sylvicultural systems; but young growth must be carefully fenced and planting is preferable to sowing.

Form factor. The proportion which exists between the volume of a tree, or portion of a tree, and that of a cylinder of the same base and height as the tree. The form factor is therefore a co-efficient with which the volume of such a cylinder must be multiplied in order to obtain the volume of the tree.

Various kinds of form factors are used in forestry:—

Stem from factors, which refer only to the volume of the stem above ground.

Tree form factors, which refer to the stem and branches, omitting root wood.

Timber form factors, which refer only to the parts of the tree classed as timber.

According to the height above ground at which the base of the tree is measured, the following kinds of form factors may be distinguished :—

Absolute form factors. The diameter is measured at any convenient height above the ground and the factor refers only to the part of the tree above that point.

True or normal form factors. The diameter is measured at a constant proportion of the height of the tree, say $\frac{1}{10}$th, $\frac{1}{20}$th, etc.

Artificial form factors. The diameter is measured at the most convenient height from the ground, namely, at breast-height.

Form factor class. All trees in a crop so similar in form that the same form factor is applicable in determining their volumes.

Fringe, Protective. *See* Protective belt.

Frost hardy. Unaffected by frost.

Frost tender. Liable to injury by frost.

Future outturn or yield. The amount of usable material or of material of all kinds which given trees upon a given area will contain after a given time.

Gauge, Diameter. *See* Calliper.

Germinate, to. To bud or sprout.

Germinating bed. An area prepared for sowing by loosening of the soil and the removal of obstructive surface covering.

Germinating power. The ability to sprout or bud.

Germinating test. To subject a certain number of seeds to conditions which secure quick sprouting in order to accurately ascertain the percentage of good seed and hence its quality.

Germination. 1. The act of sprouting or budding.
2. Young forest growth, the result of the local sprouting of seed.

Girdle, to. To kill a standing tree by making a circular incision through the bark and alburnum of a tree.

Girdling officer. An officer in charge of girdling operations.

Girth breasthigh. The girth of a tree at 4½ feet above the ground.

Girth class. *See* Diameter class.

Girth increment. *See* Diameter increment.

Girth limit. *See* Diameter limit.

Girth measure, Quarter. *See* Quarter girth measure.

Girth, Mid. *See* Mid-diameter.

Glade. A portion of a forest in which the trees are scattered, and where the undergrowth consists of grass or herbage.

Gnarled. Knotty; full of knots.

Gradation of ages. The representation of age classes in a forest crop, *See* Age gradations.

Grazing ground. An area which furnishes pasture for cattle.

Gregarious species or tree. Trees which have a tendency to form pure crops of their own species. Such species may also be called *exclusive.*

Ground cover. The shade afforded by small plants growing in a forest, except young trees; *i.e.,* ferns, mosses, grasses and weeds.

Ground fire. A forest fire which burns in the forest floor. *See* Forest fire; Forest floor.

Group method. A modification of the method of successive regeneration fellings by which the exploitable crop is felled in small groups with a view either to induce regeneration or to favour the growth of established seedlings.

Growing stock. All the living material actually standing in a forest or in part of a forest at a certain time. *See* crop.

Growth. The material produced on a tree, or in a given area, in a certain time.

Growth, Advance. *See* Advance growth; Second growth.

Grub up, to (applied to stumps). To dig up by the roots with an instrument.

Guard, Forest. *See* Forest guard.

Guide line. A narrow path, cleared on either side of a fire line or trace, before the latter is burnt.

Habit. The mode of life or behaviour of a tree in the forest.

Habitat. The locality in which a tree finds the conditions of soil and climate which it requires.

Hammer, Marking. *See* Marking hammer.

Handle, to (or trim). To remove buds or side shoots from young plants.

Hardwoods. Trees which possess a well defined heartwood.

Hardy species. Species which are capable of resisting at all ages injurious climatic influences. *See* Delicate species, Frost hardy.

Heartshake. Cracks in the centre of timber which may be due to excessive age, or to an unfavourable condition of soil. *See* Shakes.

Heartwood. The inner and older zones of wood, usually distinguished from the immature sapwood by an actual change in the tissues.

Heartwood, Imperfect or Incomplete. The absence of distinction in colour and density between the sapwood and heartwood.

Heavy thinning. The removal of a part of an immature crop including a proportion of the dominant stems. *See* Thinnings.

Heel, to. To store young trees for planting.

Height class. That portion of a crop which is approximately of the same height.

Height-growth. The increment in height of a tree. *See* Increment.

Height increment. The yearly growth of a tree in height.

Herbage. A low growth of small plants which never become woody.

High forest; or Seedling forest. A forest composed wholly or mainly of trees grown from seed. *See* Crop.

High forest, Regular. *See* Method of successive regeneration fellings.

High forest with reserves system. The whole crop standing on a portion of the area to be treated is felled in one operation with the exception of a few trees which are left to grow to a larger size. The entire area is in this way passed over once during the rotation.

Hold over, to. To leave a certain number of trees uncut for a period, usually a second rotation, after the crop itself is reproduced. *See* Leave standing, to reserve.

Humus. The comminuted earth resulting from vegetable decomposition. *See* Forest Humus.

Humus, Acid or Sour. *See* Acid humus.

Humus, Raw. *See* Raw humus.

Hundershagen's method. A method of determining the yield of a forest, based on the assumption that the real yield must bear the same proportion to the real growing stock, as that existing between the normal yield and normal growing stock.

Husk, to. To strip off the external integument or covering of the fruit or seeds of plants.

Hybrid. Plants resulting from cross fertilization of two species.

Hygrometric state of air. The degree of moisture to be found in the air; the *absolute* or *relative* humidity of the atmosphere.

Hygroscopicity of soil. The facility with which a soil spontaneously absorbs and retains moisture.

Hypsometer. An instrument for measuring the height of a tree.

Imperfect Heartwood. *See* Heartwood, Imperfect.

Impermeable (of soil). Soil which does not permit the passage of water.

Impoverishment (of the soil). Alteration of those physical properties or constituents of the soil which are beneficial to plant life.

Impregnation (of timber). The filling of the pores of timber with antiseptic solutions or preservatives.

Improvement felling. A provisional operation undertaken to improve the growth and composition of an existing crop by means of the removal of individuals impeding the development of others of greater promise than themselves; it may thus include the removal of mature trees of the principal species in order to hasten the establishment of a more vigorous crop, as well as the removal of trees of other species, which by their cover render the extension of more valuable kinds impossible.

Income, Rotation of highest. *See* Rotation of highest income.

Incomplete crop. A crop in which there is not a sufficient number of individuals, so that the trees form an interrupted leaf canopy which only partially shelters the ground.

Incomplete heartwood. *See* Heartwood, Incomplete.

Increment. The increase due to growth in a given time in the height, diameter (and girth), or volume of material of a tree or crop. Or, the material produced on a tree, or a given area, in a given time. *See* Annual increment; Current annual increment; Mean or Average annual increment; Diameter increment; Height increment.

Increment, Annual. *See* Annual increment.

Increment, Average annual. *See* Increment, Mean annual.

Increment borer. *See* Borer, Increment.

Increment, Current annual. *See* Current annual increment.

Increment, Diameter. *See* Diameter increment.

Increment, Girth. *See* Diameter increment.

Increment, Height. *See* Height increment.

Increment, Mean annual. That which is obtained by dividing the increment added during a given period by the number of years in the period. If the mean annual increment is calculated for a portion of the total age, it is called the "*periodic mean annual increment*"; if for the total or final age of the tree or wood, it is called the "*final mean annual increment.*"

Increment (volume) per cent. The proportion which exists between the total volume of a tree or wood at a certain age and the increment added during the year before or the following year.

Increment, Periodic. *See* Periodic increment.

Increment, Periodic mean annual. *See* Periodic mean annual increment.

Increment, Price. *See* Price increment.

Increment, Quality. *See* Quality increment.

Increment, Total. *See* Total increment.

Increment, Volume. The yearly growth of a tree in volume.

Indaing forest. A dry deciduous forest in Burma chiefly stocked with "In" (Dipterocarpus sp.).

Indicating per cent. *See* Forest per cent.

Indigenous. A tree growing in its original habitat. *See* Habitat.

Intermediate yield. All material from thinnings or from any cutting not intended to invite or assist reproduction. *See* Crown.

Intermittent working. When the final yield is obtained at irregular intervals.

Interrupt the cover. To form gaps and openings in the leaf canopy of a forest by the removal of trees constituting the crop.

Interrupted crop. A crop composed of trees, whose crowns do not interlace and so form an irregular leaf canopy which only partially shelters the ground.

Interrupted leaf canopy. When the crowns of the trees are detached and isolated. *See* Canopy density; Park forest.

Irregular crops. A crop formed by trees of very various ages and sizes.

Irregular forest. Uneven-aged forests. *See* Uneven-aged crop.

Isolate, to. To place selected trees in a free position by removing all surrounding trees which threaten to interfere with them.

Jhoom; or Jhum. A method of raising agricultural crops consisting in cutting down the forest, burning it and using the ashes as manure for fields made on the spot. The following are the best known synonyms:—

Berar	Dhaia.
Bombay	Dahe.
Bengal and Assam	Jhum, Katikata, Pain.
Burma	Taungya.
Madras	Ponakad, Podu.
Mysore, Coorg and parts of Madras	Kumri, Takul.
Mysore and Malabar	Tekal.
Central Provinces	Dahya, Bewar.
United Provinces (Hills)	Khil.

Judeich's method; or "Judeich's Bestandswirthschaft." A method of determining and regulating the yield of a forest, based on a consideration of the special requirements of each wood constituting the whole forest.

Kiln, Charcoal. An oven for calcining wood so arranged as to permit of the regulation of the admission of atmospheric air.

Kiln, Seed. A chamber used in order to separate seed from cones or pods by means of hot air.

Knottiness. A defect in wood due to the abnormal direction of the fibres caused by branches which have been enclosed in the wood. *See* Gnarled.

Krempe. An implement used by workmen in dragging or sliding timber along the ground.

Latent buds. *See* Dormant buds.

Layer. An undetached branch partially buried in soil, with the object of causing it to strike root and thus develop into a new tree after separation from the mother plant.

Leading shoot; or Leader. The uppermost portion of the principal axis or main trunk of a tree: the strongest topmost shoot which tends to form a continuation of the main stem.

Leaf canopy. The mass of foliage formed by the crowns of a collection of trees in a forest.

Leaf canopy, Interrupted. *See* Interrupted leaf canopy.

Leaf-fodder. The foliage and young shoots of woody plants collected for cattle fodder. *See* Fodder.

Leaf litter. That portion of the forest floor which is not in an advanced stage of decomposition. *See* Forest floor.

Leaf mould. That portion of the forest floor in which decomposition is well advanced. *See* Humus.

Leave standing, to. To leave trees uncut for a period, usually a second rotation, after the main crop is reproduced. *See* Hold over, to; Reserve, to.

Length, Merchantable. *See* Merchantable length.

Lift, to (a seedling). To pry up seedlings in the seed bed, so that they may be pulled up for transplanting.

Light demanding. A species which thrives best under the influence of direct light.

Light requirement. The necessary amount of light for the most favourable development of a species. *See* Light demanding; Shade bearing.

Light screen. A screen or frame for the partial shading of a seed bed.

Limit, Diameter. *See* Diameter limit.

Limit, Height. *See* Height limit.

Line, Compartment. *See* Compartment line.

Line, Export. *See* Export line.

Line, Fire. *See* Fire line.

Line, Guide. *See* Guide line.

Line out, to. To transplant seedlings from the seed bed to rows in the forest nursery.

Linear enumeration survey. To estimate the quality and quantity of the growing stock by counting and classifying the stems on lines of known width and length run through the crop. *See* Enumeration survey.

Litter. *See* Leaf litter.

Locality. An area considered with reference to its forest producing power.

Locality class. Localities with similar forest producing power.

Locality, Factors of the. *See* Factors of the locality.

Locality, Quality of the. *See* Quality of locality.

Locate, to (a coupe). To fix the limits and position of the coupes and the order in which the fellings should be made.

Log. A piece of wood which retains the full thickness of the stem.

Logging. To convert a stem into lengths.

Longevity (of trees). 1. The length or duration of life of a tree.

2. The length of time during which trees remain healthy and sound; or at which the reproductive power of the species either by seed or by coppice shoots ceases to be in an efficiently active state.

Loosening the soil. The cultivation of the soil for the reception of seed. The loosening of the soil may consist in merely *wounding* the soil, or in *moderately deep* or *deep* cultivation. *See* Wounding.

Lop, to. To cut off one or more branches of a tree; the operation not being done for the benefit of the tree as in pruning.

Low cover. The shade afforded by small plants not being a portion of the forest crop, such as ferns, mosses, grasses, and weeds.

Lower storey. *See* Two-storeyed forest.

Major produce. Timber and firewood.

Major or Primary part of growing stock. The dominant trees of a crop which form the crop of the immediate future. *See* Crown.

Major products. *See* Major produce.

Management. *See* Exploitation.

Management, Forest. *See* Forest management.

Map, Stock. *See* Stock map.

Marking trees for fellings. The imposition on standing trees of a recognised sign denoting that they are for removal.

Marking hammer. An implement employed to impose on timber, standing or felled, a mark denoting treatment or ownership.

Mast. The fruit of forest trees.

Mast-year. A good seed year.

Mature forest. A forest in which the crop has reached the age of maturity. *See* Maturity; Exploitable age.

Maturity. 1. The age at which the tree after its height has culminated, attains its maximum in girth measurement and begins to become unsound and to deteriorate.

2. The age at which a tree becomes exploitable.

Mean annual increment. *See* Increment, Mean annual.

Mensuration, Forest. *See* Forest mensuration.

Merchantable length. The total length of that portion of the stem which can be used under given conditions.

Merchantable timber. That portion of a tree which can be utilised as timber.

Merchantable volume. The total volume of that portion of the tree which can be used under given conditions.

Method by area. Basing the Working-Plan on the area of the forest. *See* Possibility.

Method by volume. Basing the Working-Plan on the volumetric yield of the forest. *See* Possibility.

Method by area and volume combined. A combination of the method by volume and the method by area. *See* Possibility.

Method of clearances or of clear fellings. *See* Clear felling, Method of.

Method, Coppice. *See* Coppice system.

Method, Coppice with standards. *See* Coppice with standards system.

Method, Group. *See* Group method.

Method of high forest with reserves. *See* System of high forest with reserves.

Method of improvement fellings. *See* Improvement fellings.

Method of pastoral treatment. The planting of trees in groups or lines on pasture lands. Such trees yield a certain return, besides improving the value by keeping out cold or dry winds, and by affording shelter to the cattle.

Method of selection. *See* Selection method.

Method of selection coppice. *See* Selection coppice method.

Method of simple coppice *See* Coppice system.

Method of successive regeneration fellings. In this method instead of the entire crop being removed from the area exploited in a single operation, the removal takes place gradually in successive fellings made from time to time as the new growth requires less and less shelter from the parent crop. In addition to this gradual exposure of the new growth, the young crop as it grows up, is fostered by cleanings, thinnings, etc. The successive fellings, made in connection with this method, are called *preparatory*, *seed*, *secondary* and *final*. The first and second may be either *close* or *open*. This method is sometimes called "*the method of natural regeneration and of thinnings*"; sometimes "*the shelter wood compartment system*" or "*high forest compartment system*"; and sometimes the "*uniform method.*" A forest treated by this method is sometimes called a "*regular high forest.*"

Method of storeyed forest. *See* Storeyed forest method.

Method of two-storeyed forest. *See* Two-storeyed forest.

Method, Pollard. *See* Pollard method.

Mid-diameter or girth. The diameter or girth measured half way along the length of a stem or log.

Minor produce or products. All forest products except timber and fire-wood.

Minor or Secondary part of wood. *See* Intermediate yield; and Crown.

Mixed crop or forest or wood. A crop or forest composed of trees of two or more species intermixed. The various species composing a mixed forest may be distinguished into three several classes—*principal, auxiliary,* and *accessory.*

Money yield tables. *See* Yield tables, Money.

Mother tree. A tree which provides the seed for natural reproduction.

Mould. *See* Humus.

Mould, Leaf *See* Leaf mould.

Mould, Vegetable. *See* Vegetable mould.

Mound planting. A method of planting in which the seeds or young trees are planted on mounds, ridges, or hills.

Natural pruning. The clearing of the stem through the death and fall of side branches.

Natural regeneration or reproduction. The renewal of a forest by self-sown seeds, or by stool or root shoots.

Net yield. The clear profit obtained from a forest after deducting all working expenses. The outturn of a forest.

Normal. The word "normal" applied to increment, growing stock, and present and future yield signifies that which may reasonably be expected by correct management, taking into consideration the quality of the locality, as well as any extraordinary disturbances which may be foretold. *See* Forest, Normal.

Normal forest. When in addition to being constituted of a complete series of growths of all ages from the seedling to the exploitable tree, each age-class occupying an equal area, a forest is completely stocked, and the growth is proportionate to the fertility of the soil. *See* Forest, Normal.

Normal form factor. Form factors obtained by measuring the diameter (or girth) at a constant proportion of the height of a tree, say, $\frac{1}{10}$th, $\frac{1}{20}$th, etc. *See* Form factor.

Normal yield. The yield which a normal forest can permanently give. *See* Normal forest.

Notch planting; or Notching. A method of planting by which the plant, while it is still a small seedling and before it has developed side roots of any length, is placed into a notch made with a hatchet or spade.

Nurse. A tree which fosters the growth of another in youth.

Nurse crop. A crop of trees grown for the purpose of fostering the growth of others.

Nurse, to. To shelter or protect against adverse influences.

Nursery. *See* Forest nursery.

Nursery-grown. Grown in a forest nursery.

Nursery, Permanent. *See* Permanent nursery.

Nursery, Temporary. *See* Temporary nursery.

Ocular estimates (of volume). To determine the volume of standing trees by eye-estimate.

Offence, Forest. *See* Forest offence.

Open (applied to woods). A term applied to woods in which the crowns of the trees do not interlace but form an interrupted leafy canopy which only partially shelters the ground. *See* Canopy density.

Open canopy. When the crowns of the trees hardly meet and thus do not touch one another at every point, and less than half of the ground is shaded.

Open felling. The removal of a certain number of stems of a crop, so that appreciable gaps and openings appear between the trees left standing.

Open woods. *See* Open; Wood, Open.

Opening. *See* Glade.

Operations, Cultural. *See* Cultural operations.

Operations, Plan of. *See* Plan of operations.

Order of felling. The determination for each year of a given period of the locality of the coupes in a forest.

Organization, Forest. *See* Forest organization.

Outturn. The net yield of a forest or such portion of the gross yield as has been or will be utilised.

Outturn, Future. *See* Future outturn.

Overcrowded; or Overstocked. The wood is so densely stocked as to prevent a sufficient development of the crowns of the individuals constituting the crop.

Overmature. 1. A tree or crop in which, as the result of age, growth has almost entirely ceased, and decay and deterioration have begun.

2. A tree or crop which has passed the exploitable age or size.

Overtop. A tree, the crown of which stands above that of the surrounding trees.

Overtopped. Having the crown shaded from above.

Overwood. *See* Two-storeyed forest.

Pannage. The driving of swine into the forest to feed on the mast. *See* Mast.

Parent tree. *See* Mother tree.

Park forest. When there are appreciable gaps and openings between the trees and shade occurs only in isolated patches. *See* Canopy density.

Partial sowing. When sowing is restricted to a portion of the area to be stocked. *See* Sowing in strips, patches, holes, trenches, mounds.

Pastoral treatment method. *See* Method of pastoral treatment.

Pasture. *See* Forest pasture.

Pasture ground. *See* Grazing ground.

Patch method. The clear cutting of small patches to invite reproduction by self-sown seed from the surrounding forest. *See* Clear felling, Method of.

Patch sowing. Sowing of forest seed in small plots. *See* Sowing in patches.

Per cent., Forest. *See* Forest per cent.

Per cent., Increment. *See* Increment per cent.

Per cent., Indicating. *See* Forest per cent.

Period. A sub-division of a rotation.

Period, Conversion. *See* Conversion period.

Period, Felling. *See* Felling rotation.

Period, Preparatory. *See* Preparatory period.

Period, Regeneration. *See* Regeneration period.

Period, Transformation. *See* Transformation period.

Periodic block. The part of a forest set aside to be treated during a period or number of years into which the rotation is divided.

Periodic increment. The increment added during a number of years or a period.

Periodic mean annual increment. When the mean annual increment is calculated for a portion of the total age. *See* Increment, Mean Annual.

Permanent nursery. A nursery worked continuously for the supply of plants required year after year for extensive planting operations.

Physical rotation. That age which is most favourable for the natural regeneration of a species, taking into consideration the conditions of the locality and the sylvicultural system. In the case of protection forests, parks, etc., the physical rotation may be taken as that which coincides with the natural lease of life of the trees.

Pit planting or sowing. A method of placing seeds or seedlings in excavations, which may be either narrow pits with steep sides, or shallow sloping hollows.

Plan of operations. A table showing under the various heads of forest management the order and nature of the operations to be carried out during one or more years. Such plans are based on the provisions of a regular working plan where these exist, otherwise on general sylvicultural principles.

Plan, Planting. *See* Planting plan.

Plan, Working. *See* Working plan.

Plant, Seedling. *See* Seedling plants.

Plantation. *See* Forest plantation.

Plantation, Teak taungya. *See* Cutch or teak taungya.

Planting. The method of forming a wood by means of plants which have been raised elsewhere.

Planting, Ball. *See* Ball planting.

Planting, Basket. *See* Basket planting

Planting by tufts. Planting with two or more transplants together in the same patch, pit or mound.

Planting in holes. The plant while it is still a small seedling is put into a deep narrow hole made in the ground with a stake or peg.

Planting in lines or rows. A method of planting in which the young trees are placed in lines or rows, the distance between the lines being greater than between the young trees in the rows.

Planting in notches. *See* Notch planting.

Planting in pits. *See* Pit planting.

Planting in quincunx. A method of planting in which the plants are placed at the four corners of a square and a fifth in the centre.

Planting in rectangles. When transplants are placed at the four corners of a rectangle.

Planting in ridges. A method of planting on wet ground in which the young trees are planted on ridges or mounds.

Planting in squares. When transplants are placed at the four corners of a square.

Planting in trenches. The young plants are placed in small excavations or trenches, which serve to catch the rain water.

Planting in triangles. When transplants are placed at the three corners of an equilateral triangle.

Planting on mounds. *See* Mound planting.

Planting plan. A detailed scheme for forest planting on a given area.

Planting, Ridge. *See* Ridge planting.

Plot, Experimental. *See* Experimental area.

Plot, Sample. *See* Sample plot.

Pole. A young tree from the time when the lower branches begin to fall off, up to the time when the principal height is reached. Poles are termed *small* or *large* according as they are under or over two feet in girth. *See* Stages of growth of trees.

Pole crop or forest. A forest crop consisting of poles.

Police, Forest. *See* Forest police.

Policy, Forest. *See* Forest policy.

Pollard. A tree whose crown has been cut back to invite the production of shoots.

Pollard, to. To invite the production of shoots at the top of the tree by cutting back the crown. The crown may be removed either leaving the main stem intact, or cutting it off at a certain height from the ground. In the latter case the system is frequently called topping.

Pollard method. In this method the exploitable material is obtained by periodically pollarding the trees constituting the crop, regeneration being obtained from shoots produced at the top of the tree. *See* Pollard, to.

Possibility. Theoretically the possibility is the productive power of a wooded area expressed in quantity of material. Practically it is taken to mean the quantity of material which, without infringing the rules of forestry, may be felled in a forest, annually or periodically for the time being. The possibility may be applied either by area, by number of trees, or by volume.

Possibility, Fixing the. *See* Determination of the yield.

Possibility, Potential. *See* Potential possibility.

Possibility, Actual or Present. The annual yield in material of which a forest is susceptible under existing physical, legal and other conditions affecting it.

Potential possibility. The annual yield in material of which a forest is susceptible when maintained at its highest possible limit of productiveness.

Predominant. Trees with an exceptionally vigorous crown. *See* Crown.

Predominating. A tree with a crown raised well above the level of the surrounding trees. *See* Crown.

Preliminary examination (of a forest). A reconnaissance of a forest in order to gain a general knowledge of all facts likely to be useful in determining the future plan of management.

Preparatory fellings. *See* Method of successive regeneration fellings.

Preparatory period. The length of time required in order to constitute the forest according to the normal condition is sometimes called a *preparatory period.*

Present possibility. *See* Possibility, Actual.

Pressler's borer. *See* Borer, Increment.

Price increment. The increment caused by a change in the price of forest produce generally, independently of an improvement in quality.

Prick out, to. To transplant small seedlings in a nursery.

Primæval forest. *See* Virgin forest.

Primary part of growing stock. The dominant trees of a forest crop. *See* Crown; Major part of the growing stock.

Principal fellings. The methodical removal of exploitable trees according to a pre-arranged plan. *See* Final yield.

Principal produce. The material for the production of which a forest is primarily maintained.

Principal species. That kind of trees to produce which the management of a forest is primarily designed. *See* Mixed crop.

Private forest. A forest which is not the property of a State or Government.

Privileges, Forest. *See* Forest privileges.

Produce, Accessory. *See* Accessory produce.

Produce, Forest. *See* Forest produce.

Produce, Major. *See* Major produce.

Produce, Minor. All forest products except timber and fuel such as grass, honey, gums, etc.

Produce, Principal. *See* Principal produce.

Producing stock. The growing crop or material actually standing on a given area at a certain time.

Products, Forest. *See* Forest products.

Products, Major. *See* Major produce.

Products, Minor. *See* Minor produce.

Protected forest. *See* Forest Act, Chapter IV.

Protection forest. A forest whose chief value is to regulate stream flow, prevent erosion, hold shifting sand, or exert any other beneficial effect on the adjacent country.

Protective belt. A forest which is maintained as a protection against wind, snow, or other physical forces. *See* Windbreak.

Protective fringe. *See* Protective belt.

Provisional or Temporary treatment. Operations to which the existing crop is subjected for a time so as to bring it to the condition requisite for the application of a new method of treatment. *See* Improvement fellings; Conversions; Transformations.

Prune, to. To remove superfluous branches for the benefit of the tree.

Pruning, Natural or Self. *See* Natural pruning.

Puddle, to. To dip the roots of young trees in thin mud.

Pure crop, or forest or wood. A crop formed of a single species.

Quality increment. The increase in the value per unit of volume, independently of any alteration in the general price of forest produce.

Quality class (of locality). *See* Locality class.

Quality of locality. The nature of the soil and climate, the latter being governed by the situation. The sum total of these factors represents the *quality* or *yield capacity* of the locality.

Quarter girth measure. The calculation of the volume of round timber on the assumption that the sectional area is equal to the square of a quarter of the girth.

Quincunx planting. *See* Planting in quincunx.

Radial shake. A fault in timber due to meteorological causes. *See* Shakes.

Range. A territorial executive forest charge: a sub-division of a charge of control.

Raw humus. An accumulation of leaves, needles, weeds, and moss which has remained undecomposed.

Reafforestation. 1. To re-establish forest growth either by natural or artificial means.

2. To re-establish as forest, land disforested under a Forest Act.

Regenerat (e)—ion. To renew a forest crop by natural or artificial means.

Regeneration, Artificial. *See* Artificial regeneration.

Regeneration felling. The removal of exploitable trees with the view of inviting or assisting natural reproduction. *See* Method of successive regeneration fellings.

Regeneration, Natural. *See* Natural regeneration.

Regeneration period. The space of time required for the renewal of the growing stock.

Regular crop or forest. A forest in which the leaf canopy is complete and is formed by trees of approximately the same age and size.

Regular high forest. *See* Method of successive regeneration fellings.

Rental of the soil. The annual net return of the soil.

Rental value (of a forest). The capital sum which would yield a rental equal to that which a forest is capable of yielding.

Report, Working plan. *See* Working plan report.

Reproduction. 1. The process by which a forest is renewed.

2. Forest regrowth: seedlings, shoots or suckers.

Reproduction, Artificial. *See* Artificial reproduction: Planting.

Reproduction, Natural. *See* Natural regeneration.

Reserve, to. To leave trees uncut for a period, usually one or more rotations, after the new crop is assured.

Reserve (trees). The trees permitted to remain after a clear felling. *See* High forest with reserves system: Standard.

Reserved forest. *See* Forest Act, Chapter II.

Resin or Gum blaze. A wound inflicted in the bark of trees to induce the flow of resin or gum.

Resin or Gum tapping. The process by which resin or gum is induced to flow from trees.

Restock. To renew a forest either by natural or artificial means.

Restorations. Operations undertaken in order to reconstitute or improve the forest crop without altering the method of treatment or the mode of reproduction.

Rhizome. The underground stem of bamboos.

Ride. Open cut boundary lines between compartments.

Ridge planting. A method of planting on wet ground, in which the young trees are planted on ridges.

Right. *See* Servitude.

Rights, Commutation of. *See* Commutation of rights.

Right-holder. The possessor of a claim on the property of another which diminishes the full enjoyment thereof.

Ring, to. To kill a standing tree by making a circular incision through the bark and alburnum of a tree. *See* Girdle, to.

Ring, Annual. *See* Annual ring.

Ring, False. *See* False ring.

Riparian or Riverain forest. A forest which owes its existence or condition to its situation on the banks of a river, lake, or swamp.

Ripe (for the axe). *See* Exploitable.

Road, Export. *See* Export line or road.

Rock. The geological formation underlying the soil which affects the forest by its outcrop, composition, the rapidity of its disintegration, etc.

Rooting, Shallow. Shallow rooting.

Roots, Adventitious. *See* Adventitious roots.

Rootshoot ; or Sucker. An aërial shoot springing from a root.

Rotation. The number of years determined on between the regeneration of the forest crop and its arrival at exploitable age. The following classes of rotation are distinguished :—

Financial rotation.
Physical rotation.
Rotation of the highest income.
Rotation of the greatest volume production.
Technical rotation.

Rotation, Felling. *See* Felling rotation.

Rotation, Financial. *See* Financial rotation.

Rotation of the greatest volume production. The rotation under which a forest yields the greatest quantity of material per unit of area; its length coincides with the year in which the mean annual volume increment culminates.

Rotation of the highest income. The rotation which yields the highest income, calculated without interest and irrespective of the time when the items of income occur.

Rotation, Physical. *See* Physical rotation.

Rotation, Technical. *See* Technical rotation.

Roughly squared timber. Timber with an approximately rectangular cross section.

Round timber; or Wood in the round. Timber unconverted save for convenience of transport, but with a view to its ultimate utilization.

Row planting. *See* Planting in lines.

Sale value. The price which can be realised by the sale of property.

Sample area or plot. An area of known size selected as representative of a given forest. *See* Enumeration survey.

Sample tree. A tree which is representative of a certain class.

Sand dune. *See* Dunes.

Sapling. A young tree up to the time when the lower branches begin to dry; generally a tree 3 feet or over in height, and less than 4 inches in diameter breast-high. *See* Stages of growth of trees.

Sap wood. The outer and younger zones of wood.

Sawn timber. Timber converted by the use of the saw with at least two parallel faces.

Scantling. Sawn timber of small dimensions.

Screen, Light. *See* Light screen.

Screen, Shade. *See* Light screen.

Scrub. Inferior forest growth consisting chiefly of small or stunted trees and shrubs.

Seasoning. To prepare for use by drying or hardening.

Secondary fellings. *See* Method of successive regeneration fellings.

Second growth. Forest growth which comes up naturally after cutting, fire, or other disturbing cause.

Section, Felling. *See* Felling section.

Seed bearer. A tree left standing for the purpose of providing seed for natural regeneration.

Seed bed. A specially prepared area, usually in the forest nursery, for the raising of seedlings.

Seed fellings. *See* Method of successive regeneration fellings.

Seed forest. A forest composed wholly or mainly of trees raised from seeds.

Seed kiln. *See* Kiln, seed.

Seed, Self-sown. *See* Self-sown seed.

Seed tree. *See* Seed bearer.

Seed year. A year in which a given species bears seed abundantly.

Seedling. A young plant which results directly from the germination of a seed. *See* Stages of growth of trees.

Seedling crop. A forest crop from the germination of the seeds to the time when the newly developed branches meet.

Seedling forest. Or high forest.. A crop composed of trees which have sprung from seed.

Seedling plants. Seedlings which are taken direct from the seed bed to the forest.

Seedling tree. A tree of any age sprung from seed and not from a coppice shoot.

Selection coppice method. Cutting periodically the strongest shoots, or those exceeding certain prescribed dimensions, out of each coppice clump. The regeneration fellings in this method. may be called "*Selection coppice fellings.*"

Selection felling. The methodical removal of the exploitable trees in a forest, either singly or in groups, with a view to producing from self-sown seedlings a new crop irregular in its constitution.

Selection method. Or regeneration fellings by the selection method. Removing in a methodical manner, in accordance with sylvicultural requirements so as not to exceed the possibility, the exploitable trees in a forest by felling them here and there, either singly or in groups.

Self pruning. *See* Natural pruning.

Self-sown seed. Seed sown by any agency other than man.

Semimature forest. A forest in which height growth is complete, but diameter growth has not begun to fall off.

Series, Felling. *See* Felling series.

Servitude. A claim possessed by a person, community or property to diminish the full enjoyment of the property of another.

Settlement, Forest. *See* Forest settlement.

Severance felling. A cleared strip of varying breadth, by which two woods are separated in the general direction of the cuttings, at a place where some time after regular fellings are to commence.

Shade bearer (or bearing. A species which tolerates the cover of other trees.

Shade enduring. *See* Shade bearer.

Shade screen. *See* Light screen.

Shakes. Faults in timber (of the nature of cracks) due to excessive age, cold, frosts, sudden changes of temperature, sunstroke, or to a too dry or too wet condition of soil. *See* Cupshakes; Heart shakes; Radial shakes; Star shakes.

Shallow rooting. When the root system does not extend far below the surface of the ground.

Shelter belt or wood. *See* Protective belt.

Shelter wood compartment system. *See* Method of successive regeneration fellings.

Shelter wood group system. *See* Group method.

Shelter wood selection system. *See* Selection method.

Shoot. A young branch or growth.

Shoot, Adventitious. *See* Adventitious buds.

Shoot, Coppice. *See* Coppice shoot.

Shoot, Leading. *See* Leading shoot.

Shoot, Stool. *See* Stool-shoot.

Shrub. A small woody plant which branches at or near the ground.

Shrub, Arborescent. A shrub that has a certain clear length of stem and thus assumes to some degree the habit of a tree.

Simple coppice method. *See* Coppice system, simple.

Size class. *See* Diameter class.

Slope. The gradient of the surface of the ground. The following terms are used in forest description to define the slope :—

Level	0 to 5 %	=	0° to 3·0°
Gentle	5 to 15 %	=	3·0° to 8·5°
Moderate	15 to 30 %	=	8·5° to 16·5°
Steep	30 to 50 %	=	16·5° to 26·5°
Very steep	50 to 100 %	=	26·5° to 45·0°
Precipitous	Over 100 %	=	Over 45·0°

Snag. 1. A short, sharp or rough branch.
2. An uprooted tree resting in the bed of a stream.

Snow break. 1. A tree or portion of a tree broken by snow.
2. A shelterbelt maintained as a protection against snow.

Soft wood. 1. Timber with no definite heart wood.

2. Trees of rapid growth and short duration.

Soil. The uppermost layer of the crust of the earth often more or less dark in colour from the admixture of vegetable matter, and which is (in most cases) the product of the disintegration of the underlying rock or subsoil. In forest description soils may be described according to their (i) origin and composition, (ii) depth, and (iii) moisture.

Soil cover. *See* Surface cover.

Soil covering. *See* Leaf litter.

Soil cost value. The sum of all expenses incurred in acquiring the land and rendering it fit for forest culture.

Soil expectation value. The sum of the present values of all returns expected from the soil in the course of time, less the present value of all expenses which must be incurred to obtain those returns.

Soil, Hygroscopicity of. *See* Hygroscopicity of soil.

Soil, Loosening the. *See* Loosening the soil.

Soil rental. *See* Rental of the soil.

Soil sale value. The value which the soil realises in the open market.

Soil, Top. *See* Humus.

Soil, Vegetable. *See* Vegetable soil.

Sowing at stake. To sow seed at the base of stakes which are used to mark the position of the seedling.

Sowing broadcast. When seed is distributed over the whole area to be stocked.

Sowing, Direct. *See* Direct sowing.

Sowing in furrows. The sowing of seed in strips consisting of one or two furrows made with a plough, hoe or pick.

Sowing in mounds. The sowing of seeds on prepared mounds or ridges.

Sowing in notches. The sowing of seed in clefts made by a spade or similar instrument.

Sowing in patches. The sowing of seed in small seed-beds made in lines or scattered over the area.

Sowing in pits. The sowing of seed below the level of the ground in small excavations or pits which serve to retain moisture.

Sowing in ridges. The sowing of seed above the level of the ground.

Sowing in situ. The sowing of seed in places where the resulting trees are intended to remain. *See* Direct sowing.

Sowing in strips. The sowing of seed in beds, formed by the previous cultivation of parallel, narrow strips, alternating with broader bands which are left unsown.

Sowing in trenches. The sowing of seed below the level of the ground in continuous lineal excavations.

Sowing, Partial. *See* Partial sowing.

Sour humus. *See* Acid humus.

Species, Accessory. *See* Accessory species.

Species, Auxiliary. *See* Auxiliary species.

Species, Delicate. *See* Delicate species.

Species, Exclusive or Gregarious. *See* Gregarious species.

Species Hardy. *See* Hardy species.

Species, Principal. *See* Principal species.

Species, Sporadic. *See* Sporadic species.

Sporadic species. Trees which have a tendency to grow distributed singly throughout a forest.

Square planting. *See* Planting in squares.

Stack. A pile or heap of wood.

Stacked cubic feet. Or Stacked contents. The space occupied by a pile or heap of wood in distinction to the cubic contents of the wood itself.

Stages of development of a forest crop. *See* Crop.

Stages of growth of trees. A separate individual is termed a *seedling* from the germination of the seed to the time when it begins to lose its lower branches; a *sapling* when it begins to lose its lower branches; a *pole* from the fall of the lower branches to the time when it attains its full height; and a *tree* from the time of its having attained its normal height.

Stagheaded. A tree of which a portion or all of the crown is dead.

Standard. The trees permitted to remain after a coppice felling. *See* Coppice with standard system.

Standard of the first, second, or third rotation. Trees that have remained standing through 1, 2, or 3 coppice rotations.

Star shake. Faults in timber due to excessive age, or to a too dry or too wet condition of soil. *See* Shakes.

State forest. A forest which is the property of a State or Government.

Stem. The trunk of a tree from the ground to the point where its main branches are given off. *See* Bole.

Stem analysis. The investigation of the progress of increment throughout the life of a tree.

Stem fire. A fire which ignites the stems of the trees. *See* Forest fire.

Stem form factor. *See* Form factor.

Stiff (of a soil). A soil which is cohesive and tenacious.

Stock ; or Stocking. The entire collection of trees growing on a given area. *See* Crop.

Stock, to. To cover with forest growth.

Stock, Growing. *See* Growing stock ; Crop.

Stock map. A graphic exposition of the manner in which the forest stock, species, and age classes are distributed over the forest area.

Stock, Producing. *See* Producing stock.

Stool. The lowest part of the stem of a tree, together with the roots, left when a tree has been felled close to the ground.

Stool-shoot. A stem springing from the stool or stump of a felled tree.

Storeyed forest. *See* Forest in storey.

Storeyed forest method. Forming a crop of stems of different ages, the crowns of which are arranged in tiers, the difference in age between the trees of each consecutive tier being equal to the length of the felling rotation. The method differs from that of coppice with standards, because regeneration is obtained principally by seed instead of by stool-shoots.

Strip felling. *See* Method of clear fellings, or Clearances.

Strip method of successive regeneration fellings. When regeneration fellings are made in narrow strips. *See* Method of successive regeneration fellings.

Strip sowing. *See* Sowing in strips.

Stub out, to. To root up. The grubbing out of stumps. To cut a tree or shrub out by the roots so that no stool is left.

Stump. That portion of the stem below the cut made in felling a tree.

Subcompartment. A portion of a compartment either temporarily or permanently set aside for convenience of working.

Subsoil. The stratum of earth lying between the upper soil and the rocks.

Successive regeneration fellings method. *See* Method of successive regeneration fellings.

Sucker. An aërial shoot sprung from a root.

Suppressed tree. A tree of which the growth has practically ceased as the result of too much overhead cover. *See* Crown.

Surface cover. All small plants growing in a forest, except young trees, as well as that portion of the forest floor which is not in an advanced state of decomposition.

Surface feeder. A species of which the roots spread near the surface.

Surface fire. A forest fire which runs over the undergrowth. *See* Forest fire.

Survey, Enumeration. *See* Enumeration survey.

Survey, Valuation. *See* Valuation survey.

Sustained working. A forest so worked that the soil continuously produces crops of wood from regeneration to exploitation.

Sustained yield. The material yielded by sustained working.

Sylvicultural system. A method according to which the formation, regeneration, tending and exploitation of the woods which compose a forest is effected.

Sylviculture. The formation, regeneration, and tending of forests.

System, Coppice. A method of treatment by regeneration from stool or root-shoots. *See* Coppice system.

System, High forest compartment. *See* Compartment system.

System of coppice with standards. *See* Coppice with standards system.

System of high forest. A method of treatment by regeneration from seed artificially or self-sown.

System of high forest with reserves. A method of treatment by regeneration from seed and clear felling with the exception of a few trees which are left to grow to a larger size. *See* High forest with reserves system.

System, Sylvicultural. *See* Sylvicultural system.

Systematic fellings. Fellings carried out according to some recognized sylvicultural system. *See* Sylvicultural system.

Table, Volume. *See* Volume table.

Table, Yield. *See* Yield table.

Tapping, Gum or Resin. *See* Resin tapping.

Taungya plantation, Teak or Cutch. *See* Cutch or Teak taungya.

Technical rotation. The rotation under which a forest yields the most suitable material for a certain fixed purpose.

Temporary nursery. A nursery which is used for a few years only, generally to yield the material for the planting of a particular locality, when it is abandoned and a new nursery laid out elsewhere. *See* Forest nursery.

Temporary treatment. *See* Provisional treatment.

Tender, Frost. *See* Frost tender.

Tending (of a wood). Includes the preservation of the factors of the locality by maintaining both suitable overhead and soil covering; the protection of the crop against external dangers: the preservation of the proper density of the crop and of a proper mixture of species: cleaning, pruning, thinning, and other operations for the benefit of the stock.

Test, Germinating. *See* Germinating test.

Thicket. A dense crop of seedlings from the time when their side branches commence touching or interlacing until the time when the lower branches begin to die and fall.

Thin canopy. When half to three-fourths of ground is shaded.

Thin wood. *See* Wood, Open.

Thinnings. The removal of excess stems from a crop with the object of diminishing adverse competition and affording more light and space. *See* Heavy thinning.

Tidal forests. Forests whose existence or condition is referable to the influence of the tides.

Tier, Lower and Upper. *See* Two-storeyed forest.

Timber. Wood above a certain minimum diameter or girth. For statistical purposes a minimum girth of two decimeters is taken in Europe.

Timber, Conversion of. *See* Conversion of timber.

Timber, Floatable *See* Floatable timber.

Timber form factor. *See* Form factor.

Timber impregnation. *See* Impregnation.

Timber, Merchantable. *See* Merchantable timber.

Timber, Roughly squared. Timber with an approximately rectangular cross section.

Timber, Round. *See* Round timber.

Timber, Sawn. *See* Sawn timber.

Topping. The removal of the crown of a tree by cutting off the stem at a certain height from the ground. *See* Pollard, to.

Top dry. *See* Stagheaded.

Top soil. *See* Humus.

Top sore. *See* Stagheaded.

Total increment. The increment laid on from the origin of a tree or wood up to certain age.

Taungya. *See* Jhum.

Trace, Fire. *See* Fire-line or trace.

Transformation. The change from one method of treatment to another of the same class, without altering the manner in which reproduction is obtained. The fellings made in such cases are called *"transformation fellings."*

Transformation period. The period during which the change from one method of treatment to another of the same class is effected.

Transplant, to. Planting out transplants in the forest.

Transplants. Seedlings which have been moved once or oftener in the nursery lines.

Trap tree. Dead or girdled standing trees or logs left in a forest, attacked by insects, in order to lead the pests off from the valuable tree crop.

Treatment of forests. The sylvicultural method according to which the forest crop is managed. *See* Provisional treatment.

Tree. 1. A large woody plant which at some distance from the ground produces branches.

2. The separate individuals of a crop are termed *trees* from the time of attaining normal height.

3. Under Forest Acts a "tree" includes palms, bamboos, stumps, brushwood and canes.

See Tree forest; Stages of growth of trees.

Tree, Alburnum. *See* Alburnum tree.

Tree analysis. The investigation of the progress of increment throughout the life of a tree.

Tree, Broad-leaved. *See* Broad-leaved trees.

Tree class. All trees of approximately the same size. The following tree classes are distinguished—Seedling, Sapling, Pole, Tree.

Tree compass. An instrument for the measurement of the diameter of trees.

Tree, Deciduous. *See* Deciduous tree.

Tree, Evergreen. *See* Evergreen tree.

Tree forest. A crop of trees, which has attained the period of principal height growth.

Tree form factor. *See* Form factor.

Tree, Gregarious. *See* Gregarious species.

Tree-growth. The entire collection of trees growing on a given area. *See* Crop.

Tree, Light demanding. *See* Light demanding.

Tree Mother. *See* Mother tree.

Tree, Parent. *See* Mother tree.

Tree, Sample. *See* Sample tree.

Tree, Seedling. *See* Seedling tree.

Tree, Shade bearing. *See* Shade bearer.

Tree, Sporadic. *See* Sporadic species.

Tree, Suppressed. *See* Suppressed tree.

Tree, Trap. *See* Trap tree.

Tree weed. A tree of a species which has little or no value.

Trench planting or sowing. *See* Planting in trenches; Sowing in trenches.

Triangular planting. *See* Planting in triangles.

Trim, to. To remove buds or side shoots from young plants. *See* Handle.

Trunk. *See* Stem.

Two-storeyed forest. The introduction of a second crop (usually of shade bearing species and generally by sowing or planting) into an older crop, so that practically two distinct high forests each of even-age exist on the same area. The original crop forms "the upper tier or storey" or "over wood;" the crop subsequently introduced "the lower tier or storey."

Type tree. *See* Sample tree.

Undergrowth. Large woody plants, young trees or shrubs forming the lowest tier of forest vegetation.

Underplanting. To plant young trees under an existing older crop.

Undershrub. Inferior vegetation partially woody not coming up to the dimensions of shrubs.

Underwood. The young tree growth springing up under the reserve trees. *See* Two-storeyed forest.

Uneven-aged crop. A crop of trees made up of many different age classes.

Uniform crop A crop of trees approximately all of one age or size.

Uniform method. *See* Method of successive regeneration fellings.

Unregulated or Unclassed fellings. Removal of trees, exploitable or not, and uncontrolled by any sylvicultural method.

Upper storey or tier. *See* Two-storeyed forest.

Urich's method of sample trees. A modification of the general method of sample trees.

User (right of). *See* Servitude.

Utilization, Forest. *See* Forest utilization.

Utilization value (of growing stock). The price which a wood would realise if offered for sale in the open market. *See* Sale value.

Utilization per cent. *See* Forest per cent.

Valuation, Forest. *See* Forest valuation.

Valuation survey. The determination or estimation of the value of the growing stock.

Value, Cost. *See* Cost value.

Value, Expectation. *See* Expectation value.

Value, Rental. *See* Rental value.

Value, Sale. *See* Sale value.

Value, Utilization. *See* Utilization value.

Vegetable mould. Thoroughly decomposed vegetable detritus.

Vegetable soil. That portion of the soil which contains a percentage of vegetable matter.

Village forest. *See* Forest Act, Chapter III.

Virgin forest. A natural forest uninfluenced by men.

Volume growth or increment. The yearly growth of a tree in volume.

Volume, Merchantable. *See* Merchantable volume.

Volume table. A tabular statement giving for a forest the volumes of the type trees of the different diameter classes.

Waste land. Land which is not used for any specific purposes.

Watcher, Fire. *See* Fire-patrol or watcher.

Weed tree. A tree of a species which has little or no value.

Weeding. The removal or partial cutting back of herbs, climbers, shrubs, and soft wooded trees which tend to impede the growth of a young crop.

Windfall. A tree thrown by wind.

Windbreak. 1. A tree broken by wind.

2. A natural or artificial forest maintained, as a protection against wind.

Windfirm. Able to withstand strong winds.

Wood; or Woodland. An area of defined dimensions, which carries trees or shrubs or both, and is managed for the production of major or minor forest produce.

Wood, Broad-leaved. *See* Broad-leaved wood.

Wood, Crowded. *See* Crowded crop.

Wood depôt. *See* Depôt.

Wood faggot. *See* Faggot.

Wood, Faggot. *See* Faggot wood.

Wood in the round. *See* Round timber.

Wood, Mixed. *See* Mixed crop.

Wood, Open or Thin. A wood in which the crowns of the trees do not interlace, but form an interrupted leaf canopy which only partially shelters the ground. A thin wood may be regularly or irregularly stocked.

Wood, Pure. A wood which consists of one species only.

Wood, Sap. *See* Sap wood.

Wood, Soft. *See* Soft wood.

Working capital. The producing forest stock. *See* Forest capital.

Working Circle. An area subjected to one and the same sylvicultural system and method of treatment and which is exploited by means of a distinct series of operations.

Working, Intermittent. *See* Intermittent working.

Working-Plan. A compilation of sylvicultural prescriptions regulating the management of a forest so as to best meet the wishes of the owner and indicating the means by which this purpose may be accomplished.

Working-Plan report. A document which gives in a systematic manner all the necessary information regarding a forest so that the objects for which a forest is maintained may be as fully as possible realized.

Working, Sustained. *See* Sustained working.

Wounding (of the soil). The *superficial loosening* of the soil with the rake, harrow, or hoe as a preparation for broadcast sowing, or to encourage natural regeneration by seed.

Yearling. A one year old seedling, shoot or sucker.

Yield. The total volume or quantity of all produce whether removed, utilized, or not.

Yield capacity. The total quantity of material of a given species which a given area is capable of producing under normal conditions as long as the factors of the locality remain unchanged.

Yield, Determination of. *See* Determination of the yield.

Yield, Final. *See* Final yield.

Yield, Future. *See* Future outturn.

Yield, Intermediate. *See* Intermediate yield.

Yield, Net. *See* Net yield.

Yield, Normal. *See* Normal yield.

Yield, Possible. *See* Potential possibility.

Yield, Present. *See* Possibility, Actual.

Yield, Sustained. *See* Sustained yield.

Yield table. A tabular statement which gives the course of the development of a wood from early youth up to a certain age, either from year to year, or for intervals of a certain number of years.

Yield table, Money. A tabular statement which gives the course of the development of the money value of a wood from early youth up to a certain age, either from year to year, or for intervals of a certain number of years.

APPENDICES.

APPENDIX I.—The Sylvicultural Systems.
APPENDIX II.—Sylvicultural Systems—Indian, English and American synonyms.
APPENDIX III.—Forestry Terms peculiar to the United States of America.

APPENDIX I.

The Sylvicultural Systems.

- 1. Sylvicultural systems.
  - A. Permanent systems.
    - 1. High or Seedling forest system.
      - (i) Method of clear fellings.
        - (*a*) By compartments.
        - (*b*) By strips.
        - (*c*) By patches.
        - (*d*) With reserves.
      - (ii) Method of successive regeneration fellings.
      - (iii) Group method.
      - (iv) Selection method.
      - (v) Storeyed-forest method.
    - 2. Coppice forest system.
      - (i) Simple coppice method.
      - (ii) Coppice selection method.
    - 3. Combination of seedling and coppice forest system.
      - (i) Coppice with standards method.
  - B. Provisional systems.
    - 1. Improvement fellings.
    - 2. Conversions.
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- II. *Quasi*-Sylvicultural sytems.
  - ......
    - 1. Taungya method (with tree planting).
    - 2. Method of pastoral treatment.
    - 3. Pollard (or Branch coppice) method.
    - 4. Forestry combined with rearing of game.

APPENDIX II.

Sylvicultural Systems—Indian, English and American synonyms.

Indian Forest terminology.	English synonyms.	U. S. America synonyms.
I.—SYLVICULTURAL SYSTEMS.		
A.—PERMANENT SYSTEMS.		
1. *High or seedling forest.*	1. *High or seedling forest.*	1. *Seed system.*
(i) Method of clear fellings.	(i) Clear cutting in high forest.	(i) Clean cutting method.
(*a*) By compartments	......	......
(*b*) By strips	......	Strip method.
(*c*) By patches	......	Patch method.
(*d*) With reserves	High forest with standards.	Reserve seed method. Group seed method.
(ii) Method of successive regeneration fellings.	(ii) The shelterwood compartment system.	(ii) The stand method.
	The method of natural regeneration and of thinnings.	Strip stand method, (*i.e.*, Regeneration fellings in strips).
	The Uniform method.	
	High forest compartment system.	Scattered seed method, (*i.e.*, a seed felling and a final felling).
	Method of successive thinnings.	
(iii) The group method.	(iii) The shelterwood group system.	(iii) The group method.
(iv) The selection method.	(iv) The shelterwood selection system. Jardinage system.	(iv) Single tree method.

APPENDIX II—*contd.*

Sylvicultural systems—Indian, English and American synonyms—contd.

Indian Forest terminology.	English synonyms.	U. S. America synonyms.
(v) Storeyed-forest method.	(v) Storeyed high forest.	(v) Storeyed-forest method.
2. *Coppice forest system.*	2. *Coppice forest.*	2. *Sprout system.*
(i) Simple coppice method.	(i) Coppice system.	(i) Sprout method.
(ii) Coppice selection method.	......	......
3. *Combination of seedling and coppice forest system.*	3. *Combination of seedling and coppice forest.*	3. *Composite system.*
(i) Coppice with standards method.	(i) Coppice with standards system. Stored coppice.	(i) Reserve sprout method.

B. PROVISIONAL SYSTEMS.

1. *Improvement fellings.*	......	1. *Improvement thinnings.*
2. *Conversions.*	2. *Conversion.*	......
3. *Transformations.*	......	......

II. *QUASI*-SYLVICULTURAL SYSTEMS.

1. *Taungya method.*	1. *Forestry combined with growing of field crops.*	1. *Combined cropping.*
2. *Method of pastoral treatment.*	2. *Forestry combined with pasture.*	......
3. *Pollard method.*	......	......
......	4. *Forestry combined with rearing of game.*	......

APPENDIX III.

Forestry terms peculiar to the United States of America and their English equivalents.

[From "Terms used in Forestry and Logging." U. S. Department of Agriculture.]

American term.	English equivalent.
Absolute forest soil	Soil only fit for forest growth.
Accident yield	Trees which are cut on account of accident, as, for example, damage by wind, snow, insects, fire, etc.
Accretion	Diameter or height increment.
Accretion borer	Increment or Pressler's borer.
Accretion thinning	Heavy thinning. Isolation of selected trees.
After growth	Natural reproduction.
All-aged forest	Uneven-aged forest.
Back fire	Counter fire.
Burn	Brulé.
Combined cropping	Combination of forest and field crops on the same area. Taungya plantations.
Composite forest	Coppice with standards forest.
Conservative lumbering	Systematic working of a forest for a sustained yield.
Cull, to	To make a selection felling.
Culled forest	A forest in which a selection felling has been made.
Cut-over forest	A forest from which the trees of a merchantable size have been removed.
Cutting series	Felling series.

APPENDIX III—*contd.*

Forestry terms peculiar to the United States of America and their English equivalents—contd.

American term.	English equivalent.
Deaden, to	Girdle, to.
Dry pruning	Pruning dead branches.
Duff	Litter.
Fail spot	A place where natural or artificial reproduction has failed.
First growth	Virgin forest.
Forestation	Afforestation.
Forest extension	Afforestation.
Forestral	Pertaining to forestry.
Forest replacement	Re-afforestation.
Green pruning	Pruning live branches.
Group mixture	A mixed forest in which trees of the same species occur in small groups.
Group seed method	Clear fellings with reserves in groups.
Harden off, to	To prepare seedlings in the seed bed for transplanting by gradually exposing them to wind and sunlight.
Heel in, to	To store young trees for planting by laying them against the side of a trench and covering the roots with earth.
Hill planting	Mound planting.
Improvement thinning	Improvement felling.

APPENDIX III—*contd.*

Forestry terms peculiar to the United States of America and their English equivalents—contd.

American term.	English equivalent.
Income rotation	Rotation of the highest income.
Increment	Volume or value increment.
Index	Normal.
Index forest	Normal forest.
Intolerant	Light demanding.
Large pole	A tree, 8-12 inches in diameter breast-high.
Large sapling	A sapling 10 feet or over in height.
Method of successive fellings	Method of successive regeneration fellings.
Mixed seedling and sprout forest.	Coppice with standards.
Mold	Humus. Leaf Mould.
National forest	Crown or Government forest.
Patch method	Method of clear felling by patches.
Plot survey	Enumeration survey by sample plots.
Pole	A tree, 4-12 inches in diameter breast-high.
Removal cuttings	Successive regeneration fellings.
Reserve seed method	Method of clear fellings with reserves.
Reserve sprout method	Method of coppice with standards.
Rock in, to	Planting in.

APPENDIX III—*contd.*

Forestry terms peculiar to the United States of America and their English equivalents—contd.

American term.	English equivalent.
Row planting . . .	Planting in lines.
Sapling	A tree 3 feet or more in height, and less than 4 inches in diameter breast-high.
Scattered seed method . .	Method of successive regeneration fellings (with only a seed felling and a final felling).
Scratcher	Bark-blazer.
Second growth . . .	Natural regeneration.
Section analysis . . .	Stem analysis to determine diameter growth only.
Silvical	Sylvicultural.
Silvical rotation . . .	Physical rotation.
Silvics	Habit; Sylvicultural characteristics.
Single tree method . .	Selection method.
Single tree mixture . .	A mixed forest in which trees of different species occur singly.
Small pole . . .	A tree 4-8 inches in diameter breast-high.
Small sapling . . .	A sapling, 3-10 feet in height.
Sprout	Coppice.
Stand class	Quality of locality class.
Stand fire	Stem fire.
Stand method . . .	Method of successive regeneration fellings.

APPENDIX III—*concld.*

Forestry terms peculiar to the United States of America and their English equivalents—concld.

American term.	English equivalent.
Stand table	Yield table.
Stratify, to	To preserve tree seeds by spreading them in alternate layers of sand and seed.
Strip method . . .	Method of clear fellings by strips.
Strip stand method . .	Method of successive regeneration fellings by strips.
Stump age . : . .	The age of a tree as determined only by ring countings on stumps.
Stump analysis . . .	Ring countings on stump surface.
Tolerant	Shade bearing.
Tree scribe	Bark-blazer.
Veteran	A tree over 2 feet in diameter breast-high.
Volume rotation . . .	Rotation of the greatest volume.
Volunteer growth . . .	Natural regeneration in deserted fields.
Wind mantle . . .	Shelterbelt.

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NOTE ON

LAC AND LAC CULTIVATION.

FROM PRACTICAL EXPERIENCE OF THE SAME.

1. What is lac and how it is formed.—Lac is the resinous incrustation formed by a species of scale insect called *Tachardia lacca* on twigs of certain trees.

2. This insect on swarming out of its mother-cell is a minute larva, which, when seen through the ordinary student's pocket lens, looks like a louse, red in colour, with three pairs of legs and two antennæ. It broadens out at the head, and has two minute white tufts of hair on the back behind the head and a tuft further back, the former indicating the respiratory and the latter the excretionary channels.

3. These larvæ, on swarming, move up and down the branch to which the seed-lac is tied within a radius of about 4 feet in search of sappy twigs; if they fail to find these within a period of from 8 to 12 hours they die. High wind and heavy rains at the time of swarming blow away and kill the larvæ. It is therefore a wise provision of Nature that the swarming continues for a fortnight, so that unless adverse weather prevails for the whole fortnight the entire brood for the season cannot be killed out.

4 As soon as they come across a suitable sappy twig they attach themselves to it, and begin imbibing the juice and exuding a very thin layer of resin round themselves. For the first 2 to 2½ months after attachment the growth in size of the insects and the exudation of resin around them is so small that any increase in size is hardly appreciable to the naked eye. Certain changes, however, take place in the structure of the larvæ during this period, and they ultimately develop into male and female insects.

5. The female insects lose their legs and antennæ and are merely little sacs with the tufts of hair above referred to and beak-like mouth. The male insects look like the original larvæ somewhat increased in size. They crawl out of their scales, impregnate the females, and then die.

6. If this impregnation is incomplete owing to climatic or other causes, the female insects linger on for a short period and then die. The result then is the entire failure of the lac-crop for the season.

7. If, however, the impregnation is satisfactorily performed, the activity of the female insects increases, they rapidly grow larger and go on exuding more and more lac each day. To keep pace with the rapid exudation of lac the abovementioned tufts of hair, which are mere filamentary tubes for breathing and getting rid of the excreta, suddenly grow longer, and give the tree infected with lac a sort of white cottony appearance, called by the local lac-cultivators " Rōōēē," which predicts a good lac crop for the season.

8. The female insects after impregnation continue to grow in size adding on to the lac incrustations around them for about 2½ months, when the growth stops, the insect abstains from food, and goes through a period of rest for about a month.

9. This period of rest was determined by removing the lac from the twigs a month before the actual time of swarming and keeping the same carefully spread out in thin layers of about 2 to 3 inches thick with the result that this gave a brood of larvæ at the same time as the seed-lac remaining on the tree. This period of rest ought to save the lac-cultivator one month of watching, if he has a safe place in his hut in which he can keep the lac grains removed from the twigs and spread them out in layers of from 2 to 3 inches thick while constantly stirring them. Bamboo platforms plastered with mud raised one above the other will do well for this purpose. The lac so kept will fetch a better price, as it will be practically free from colouring matter after the swarming out of larvæ from it.

10. During this period the red liquid in the insect sac gets converted into eggs which produce the larvæ for the next brood.

11. We have thus two broods of lac-insects in a year and consequently two lac-crops, one lasting generally from July to December and the other from January to June.

12. The exact time of swarming varies with the kind of trees on which the seed-lac is raised and the latitude of the locality, thus for instance from the seed-lac raised on *Butea frondosa* (dhák) the swarming takes place earlier than from that raised on *Schleichera trijuga* (kusam), and the swarming takes place earlier in the Central Provinces than in the United Provinces. The exact time of swarming

can be ascertained by careful observations after the period of rest begins; it will be found that the red liquid gradually thickens for about 20 days until the eggs are formed, and the larvæ hatch out about a week later.

13. *Kinds of lac and their uses.*—The lac from the forest is known as—

(i) twig-lac, *i.e.*, twigs with lac incrustations,
(ii) grain-lac, *i.e.*, lac incrustations removed from the twigs,
(iii) seed-lac, *i.e.*, twigs bearing lac suitable for producing a fresh brood of larvæ.

14. The grain lac is locally purchased by petty dealers and sent to the larger trade centres, the principal being Mirzapur, where it is made into shellac and button-lac and exported to Europe and America.

15. There it is used as an ingredient for lithographic ink, for varnishes, polishes, sealing wax, and there is a very considerable demand for it for electrical works and gramophone records.

16. If lac is removed from the tree before the swarming takes place, it contains the resin incrustation and the red liquid in the mother-cell, which yields the lac-dye. Formerly, when there was a ready market for this dye, the expenditure incurred on separating the dye from the resin was justified by the profit obtained, but now that there is little sale for it on account of the cheapness of anniline dyes the laborious and expensive manipulation demanded in order to extract this dye generally precludes any margin of profit. The value is further reduced unless great care is taken in bringing the lac from the forest to the huts and thence to the local dealers, for if allowed to lie uncared for, or kept lying by in a bag for a time, it gets coagulated with the result that the mother insects die of suffocation and set up decomposition, which discolours the lac.

17. Mr. Puran Singh, Imperial Forest Chemist, has analysed this coagulated lac and found that it is only its appearance that is spoiled, the yield of lac-resin from it being nearly the same as from *Phungi*, *i.e.*, good lac kept with care and from which the larvæ have swarmed out. He has further succeeded, after a careful research, in discovering a cheap and easy chemical process, by which the dye, the cell-wall, and other matter are quickly and entirely separated from the lac-resin. His process should therefore save the lac-cultivators considerable

trouble, give them better returns, and enable the manufacturers to place on the market a better quality of lac at a *reduced cost.*

18. *Trees suitable for infection.*—The trees most suitable for the production of lac are—

(i) Kusam—*Schleichera trijuga*, and
(ii) Dhák (Palás)—*Butea frondosa.*

19. Kusam is found scattered in forests fringing the slopes of ravines and on the banks of rivers. As it is a larger tree than Dhák the yield per tree is proportionately larger than for Dhák, and the lac produced on it is more valuable. In places where both Kusam and Dhák are found, people infect Kusam in preference to Dhák.

20. Dhak is very gregarious in habit and is found growing pure in large patches all over the forest, growing very well on black cotton soil and in abandoned cultivation. As it grows gregariously the lac yielded by it is more easily and cheaply collected than that yielded by the Kusam.

21. *Infection how carried out.*—The seed lac from Kusam is used to infect both Kusam and Dhák, but that from Dhák is only used to infect Dhák. From experiments made in the Raipur Division, Central Provinces, it has been found useless for the infection of the Kusam, probably because either the larvæ from lac raised on Dhák have difficulty in imbibing the sap from Kusam, which is a tougher tree, or perhaps because the Kusam sap is unfavourable to their development.

22. About a fortnight before the swarming, the twigs covered with seed-lac are broken off; they are then cut up into pieces 6 to 8 inches long and tied into bundles of 3 to 5 pieces each, weighing about 4 to 6 oz.

23. If the trees which it is desired to infect are at a distance of some days journey from the place where seed is available, the latter is carefully brought in banghi loads sheltered from the sun's rays, made into bundles, and stored until it is required for tying when the swarming begins.

24. In the case of the trees being close, the seed bundles are carefully stored and watched from day to day to see when the swarming begins. Where the first larvæ begin to swarm out the seed bundles are tied on to the trees to be infected.

25. They are tied to the forks of branches, that have thrown out

sappy twigs, at a distance of 6 to 8 feet apart having due regard to the direction of the wind, so that the larvæ blown away by the wind may fall on other sappy twigs of the same tree and not be lost.

26. The number of bundles for each tree depends on the size of the crown, and the abundance of good succulent twigs in it. A fairly large Kusam tree will require as many as 20 bundles, while for a moderate-sized Dhák about 4 bundles may be sufficient. The amount of seed tied on depends of course on the amount of seed available, *i.e.*, if a cultivator has seed of his own he can afford to be more liberal in the quantity he ties on, whereas if he has to purchase the same he has to practise economy.

27. There is no fixed selling rate for good seed-lac. Usually it sells at a higher rate than the ordinary twig-lac, as it remains on the tree for a longer period and thus runs the greater risk of theft.

28. The *following are some of the enemies* that damage a lac crop :—

(i) Rain.
(ii) Hail.
(iii) Squirrels.
(iv) Monkeys.
(v) Insects.
(vi) Forest fires.
(vii) Man.

29. Heavy rain is harmful at the time of the swarming, as it washes down and kills the larvæ, as also at the time of the evolution of the male insects.

30. Hail storms damage the lac crops to some extent if they occur during the swarming, but prove disastrous if they occur at the time of the evolution of the males, since, if the males are killed out before impregnation, the entire crop will be a failure.

31. Squirrels do some damage by cutting out the resin incrustations probably for the sake of eating the contents of the cells. They are trapped and killed. The traps consist of thin stone slabs, set up at an angle, on a level piece of ground below the trees infected, by means of an ingeniously constructed bamboo catch, which at the slightest touch falls on and crushes the squirrel.

32. Monkeys do damage out of pure mischief. They disarrange the seed-bundles and break down branches with young lac on them,

and have to be scared away. Some of the lac-cultivators tie a number of sticks made out of branches of miscellaneous trees about 3 feet long and 2 inches in diameter to the branches of the Kusam trees infected by means of strings of bark. These sticks keep waving to and fro in the wind, and the noise they make by striking one against another frightens the monkeys away from the trees.

33. *Insects.*—Catterpillers of certain moths are reported to be doing damage to the lac, but careful observations have yet to be made in order to ascertain the exact damage done by them, and to devise means to get rid of this pest.

34. Forest fires kill the lac insects and destroy the crop for the season. It is advisable, therefore, to have lac-areas always in fire-protected forests. If this is not possible, the areas should be selected in forests open to grazing, as grazing keeps down the growth of grass and the effects of fires are consequently less harmful. Ploughing the ground underneath and for some distance around the Kusam trees infected with lac will remove the tall grasses, where there is no grazing.

35. *Man.*—The most harmful enemy to lac is man. A handful of lac-bearing twigs means a few annas in the local weekly bazar, and the work of removal is so quickly done, that the lac-cultivator has to keep a regular watch both day and night for at least 3½ months each season, *viz.*,—for a fortnight from the time the seed-bundles are tied till the swarming is completed and the bundles taken down, and for 3 months from the time of impregnation when the lac becomes saleable, till the seed-twigs are broken off on the ripening of the seed. Neglect for one night may result in the removal by theft of the entire crop of one or more trees. The watching is more difficult in the forest than in village lands, where the trees are mostly in open fields.

36. *Crop and Yield.*—As mentioned before there are annually two lac-crops, one ripening about the end of the first half of the year, and the second at the end of the year. The second crop yields generally more lac than the first, the yield from the latter being mostly used for seed purposes.

37. A fairly large Kusam tree with a good crown yields as much as 40 to 60 lbs. of grain lac, while smaller trees yield from 4 to 20 lbs. The average sized Kusam can safely therefore be said to yield 8 lbs.

38. A good sized Dhák tree growing under favourable circumstances is capable of yielding 10 to 15 lbs. of grain lac, but as most Dhák trees are small, the yield varies from 2 to 6 lbs. and the average may be taken as 3 lbs.

39. *Financial Results.*—Taking the average yield of Kusam to be 8 lbs. and Dhák 3 lbs. and the selling price in the forest to be 8 annas and 6 annas a lb. of grain lac respectively, the nett revenue derived is Rs. 2 per Kusam and annas eight per Dhák tree per annum as detailed below :—

Kind of tree.	Yield.	Selling rate per lb.	Total.	Expenses incurred on account of the purchase of seed, supervision, etc.	Nett Revenue.
		R a. p.	*R a. p.*	*R a. p.*	*R a. p.*
Kusam . . .	8 lbs.	0 8 0	4 0 0	2 0 0	2 0 0
Dhák . . .	3 lbs.	0 6 0	1 2 0	0 10 0	0 8 0

40. Lac is annually exported from India and Burma to the value of over three crores of rupees, of which the lac raised on trees in the Government forests forms a very small proportion, the bulk coming from private forests and village lands, where an irregular system of lac cultivation is followed to the gradual detriment of the trees infected.

41. From the nature of the uses to which lac is put in foreign countries it is evident that the demand exceeds the supply, and it might well be worth the while of the Forest Department to encourage the extension of this industry.

42. All forests do not contain Kusam, but Dhák is of very common occurrence, and if Range and Sub-divisional Officers were to do their best to encourage lac-production, they could frequently add a few thousand rupees to the annual revenue of their charges and do credit to themselves.

43. *Working.*—From what has been stated above it will be gathered that lac-cultivation is not an easy operation. It requires a great deal of tending and care, which can only be afforded by people living on the spot. If we have our forests full of Kusam and Dhák, but no forest villages near, it is difficult to start lac-operations,

44. If there are no villages near, the possibility of creating such within the forests in suitable sites should be considered.

45. The villagers should be treated with sympathy and kindness and might well be given advances of money, for the purchase of plough-cattle, seed-lac and food-grains, to be recovered from the sale-proceeds of their lac crops. This might help them to keep outside the clutches of the money-lenders.

46. Old silted up tanks should be deepened and bunds repaired in the interest of the cattle, and every reasonable facility given to cultivators to enable them to start comfortably in life in their new villages.

47. After they have finished constructing their huts, the small culturable area that is found within the village limits should be apportioned out among them and the number of trees to be infected by them with lac should be laid down.

48. When a forest tree is put under lac for the first time, the yield is poor, because there is a lot of dead wood on it and the branches and twigs are woody. The yield continues poor until all the smaller branches and twigs are replaced by succulent pollard-shoots; this takes about 2 to 3 years from the time of starting the plantation.* The profits of the forest villagers are therefore for the first three years very small.

49. The Forest Department should realize this and be satisfied with taking only a small share of the proceeds of the lac-crops. In Raipur, Central Provinces, the Forest Department at first took only one share out of four and allowed the cultivators the remaining three shares, with which they were perfectly satisfied. This proportion may be increased after the first three years, or a fixed royalty per tree per annum recovered from the cultivators as is convenient.

50. After the lac-plantations are well started through forest villagers, the right to collect lac from the forest may be given out on leases extending from 3 to 5 years. In that case among other conditions the following should be entered in the agreement with the lessee:—

(i) that he should purchase lac from the forest villagers at rates to be fixed by the Divisional Forest Officer from time to time, and give them no unnecessary trouble.

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* The above period of poor yield may be lessened by judicious pollarding done in advance during the first rotation.

(ii) that he should take steps to systematically increase each year of his lease the number of trees under lac.

(iii) that he should see that at the end of his lease he leaves a certain number of trees infected with lac in the area leased, subject to a fixed penalty per tree found short of the number agreed upon.

51. After safe-guarding the interests of the forest villagers, it is necessary to say something about the protection and improvement of the trees which yield lac. Lac insects imbibe sap from the trees infected and make the same into lac-scales on the twigs to which they attach themselves. These twigs are cut or broken down at the harvesting of the crop and replaced by pollard-shoots. If these latter are again infected and the cultivation carried on continuously for a number of years, it stands to reason that the trees infected, however hardy they may be, will lose vigour and deteriorate. In private forests where lac-cultivation has been carried on from year to year for the past several years, trees infected have deteriorated to such an extent that some of them have lost the power of throwing out pollard-shoots; in place of the shoots, clusters of leaves appear at the ends of half-dead branches. Such trees are useless for the production of lac, and it is doubtful whether they will ever recover their vigour and throw out good shoots again.

52. The following few rules will be useful for the successful working of a lac area:—

(i) The infection should be carried on on a suitable rotation, which has yet to be determined both for Kusam and Dhák. From what little experience we have of the work, a rotation of 3 years seems to be the shortest that can be laid down.

(ii) No trees smaller than 3 feet girth for Kusam and 1′ 6″ girth for Dhák should be allowed to be infected, as smaller trees, although they yield a good quantity of lac in proportion to their size, deteriorate very soon and die when their branches are broken off.

(iii) No branches bigger than 2 inches in diameter should be allowed to be cut down or broken while gathering the lac-crop, or at the pollarding that may be resorted to during the first rotation. If some such rule is not enforced the cultivators to save themselves the trouble of climbing up the trees to cut down the lac-bearing twigs, will cut big branches and unnecessarily damage the trees.

(iv) Natural regeneration of Kusam and Dhák should be assisted and encouraged in every way possible. Dhák seeds profusely and the seedlings grow rapidly, but they are much injured, when young, by the grazing of buffaloes in the beginning of the rainy season, when there is no green grass to be had in the forest. If protection against this grazing is given to Dhák, no artificial regeneration will be necessary.

Kusam is comparatively a slow growing tree, but it is more hardy, and less subject to deterioration than Dhák if put under lac. Freeing the heads of Kusam saplings and poles from miscellaneous growth, and opening up cover round promising young Kusam stems will tend to induce them to grow into trees with crowns suitable for lac-infection.

(v) Sowing and planting should also be systematically undertaken, and the habits and the rate of growth of the trees carefully observed and studied in the various localities.

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1. *Distribution.*—Sâl is the principal forest tree in Bengal, and occurs in greater or less abundance in all of the Bengal Government forests, with the exception of the maritime swamp forests in the Sundarbans and of the hill forests of the Darjeeling district, which are over 3,000 feet in elevation.

Thus it occurs in places with greatly differing soils and climate, and the various kinds of localities in which it grows may be conveniently divided into four types, *viz.*—

(*a*) *Very favourable localities,* where the soil is deep, fresh and fertile from a forest point of view and the rainfall is considerable or heavy, say 60 inches to 200 inches a year; such are (*i*) the sâl-producing areas in the Kurseong terai and on some of the most favourable slopes in the Tista valley, (*ii*) the valley type areas in Singhbhum, and (*iii*) the high lying valleys, elevation 1,100 feet to 1,500 feet, in Angul.

(*b*) *Favourable or fairly favourable localities,* where though the summer is hot and dry and the rainfall is only moderate, 45 inches to 65 inches, whilst the surface soil is often shallow, other conditions, such as fertility, the absence of frosts and permeability of the sub-soil are favourable; for instance, half valley type and a considerable part of the hill type areas in Singhbhum, the bulk of the sâl-producing areas in the central parts of the Angul reserves, the southern forests in Puri and Sambalpur, and most of the Sonthal Parganas sâl forests. Though they are subjected to heavier rainfall and differ in some other respects, the bulk of the sâl-producing areas in the hill forests of Darjeeling may be included in this type.

(*c*) *Unfavourable localities*, where most conditions are as for type (*b*), but either the surface soil is unfertile from a forest point of view or the sub-soil is impervious; for instance, the Northern Puri and Sambalpur forests, most of the low-lying plains and valleys in Angul, and parts of the hill type areas in Singhbhum.

(*d*) *Unfavourable localities*, where, other conditions being as for type (*b*) or type (*c*), severe frosts from time to time occur; for instance, nearly the whole of the sâl-producing area in Palamau and Hazaribagh.

As, within limits, the fertility of the soil from a forest point of view varies with the treatment it receives, the above distinctions are not in all cases of a permanent character. Under good management some localities of type (*b*) may improve to such an extent that it may become possible to regard them as of type (*a*), and so on.

2. *Production of flowers, seed and seedlings.*—Sâl flowers more or less profusely almost every year. The flowers begin to appear in March just after or just before the fall of the last of the leaves of the previous year, and the new crop of leaves appears just after or along with the flowers. The maturing of a good crop of seed is, however, often prevented by unfavourable weather, and only one year in three, about, is a really good seed year.

Sâl seed ripens and falls to the ground in June or July. When it falls in wet weather the seed germinates in a few days, but when its fall is followed by a long continued drought, all or almost all of the seed dries up and fails to germinate. In continuously wet weather some of the seed may germinate before it falls from the parent trees.

Sâl seed which falls in favourable weather appears to germinate freely in all places except those where the soil is covered with a very dense undergrowth. But in dry localities where the soil is poor and there is little or no shelter from the sun all or nearly all of the seedlings die very rapidly, whilst in a damp climate the combined effects of a fairly complete tree canopy and of an undergrowth of shrubs or herbaceous plants prove equally destructive. But even in relatively dry tracts, when rainfall is well distributed and the soil is completely or partially sheltered by trees or undergrowth, numbers of seedlings survive their first cold weather and the following summer and, if subsequent conditions are favourable to their development, in the end grow into saplings and trees. In the damp tracts, sâl seedlings are more likely to suffer during their first year from excessive shade either of the tree canopy or of the undergrowth, or from both, than from exposure and drought. But even in these tracts seedlings survive in considerable numbers in all but the wettest or shadiest places for more than a year.

In dry tracts it usually happens that, to begin with, the aboveground parts of sâl seedlings die down during the cold weather or summer, whilst the roots retain their vitality and send up new shoots when the next rains begin, and in many places this dying down of the upper parts and putting forth of new shoots by the roots must be repeated annually for a number of years before the plants can acquire sufficient strength to send up shoots which can persist through a hot weather. But this drying up of the upper parts appears to be the exception in the Terai, and it is probably far from universal in other localities of type (*a*).

When sâl seedlings have been kept alive for one year their subsequent development depends on various conditions. In a relatively dry climate they nearly everywhere tolerate a fairly heavy shade, whilst they benefit from a certain amount of cover, such as is supplied by an interrupted canopy of trees or a light undergrowth, till they are well established saplings 8 feet or 10 feet high. In the hottest situations they bear and benefit from a fairly complete cover. But in damp climates, for instance in the Terai, any complete cover is destructive to sâl seedlings over 1 or 2 years old; and though seedlings will in many cases survive for many years under a moderately dense shade, they in such conditions make very little upward growth and gradually lose their vitality. In fact, it is probably the case in the Terai that shade can be only useful to sâl seedlings over 1 year old in an indirect manner, *i.e.*, by helping to keep down weeds and creepers; and as some of the last described plants stand shade better than sâl seedlings, this indirect use of shade does not always benefit the latter.

3. *Rates of growth and exploitable sizes.*—In dry localities sâl seedlings may take 10 years or more to form persistent shoots, and 20 years or more from the time of germination to become established saplings 8 feet or 10 feet high. But in the Terai when sâl seedlings are not kept back by shade or creepers, and if other conditions are

favourable, they should be 9 inches to 18 inches high when they are 2 years old, and they should become well established saplings 8 feet to 10 feet high in 6 to 10 years.

Having reached this stage the growth of the plants till they attain a girth of about 3 feet should be rapid or fairly rapid, whether the climate is damp or dry. But much depends on the quality of the soil and immediate surroundings, such as the presence or absence of overhead shade or creepers and the density of the crop. So far as can be ascertained from existing sample plots the period necessary for such a sapling to grow into a tree 3 feet in girth ranges from 20 to 30 years in the Terai to 80 or 90 years in localities of types (*c*) and (*d*) which are not exceptionally unfavourable.

The average girth increment of trees which are between 3 feet and 6 feet or 7 feet in girth varies greatly. In the case of trees growing in exceptionally unfavourable positions in localities of type (*c*) or (*d*) this increment may be reduced to insignificance before a girth of 4 feet is attained, and trees placed in slightly less unfavourable conditions grow very slowly indeed whilst their girth increases from 3 feet to 4 feet 6 inches or 5 feet, and they generally begin to decay before attaining a girth of 6 feet. But leaving out of consideration these exceptionally unfavourable places, the girth increment at this stage may be said to vary from a third to half an inch a year in localities of types (*b*), (*c*) and (*d*) and from six-tenths to one inch or over in localities of type (*a*). Thus in the best parts of the Terai trees may attain 6 feet in girth in 50 to 60 years, exclusive of the time required for the growth of a sapling 8 feet to 10 feet high. In the valley type areas in Singhbhum the corresponding period probably varies between 100 and 140 years, whilst in ordinary localities of type (*b*) it probably varies between 140 and 180 years. In ordinary localities of types (*c*) and (*d*) it is probable that only a small proportion of the trees attain girths of 6 feet or over, and that trees which do attain such a girth are usually over 200 years old.

The above remarks only apply to well grown trees which have reasonable or ample space for the development of their crowns. Suppressed or partly suppressed trees grow very slowly indeed, even in favourable localities. In the Bhamanpokri sample plot in the Terai, there are suppressed trees of which the yearly girth increment during 25 years has averaged less than a tenth of an inch. In considering the sizes to which sâl trees should be allowed to attain before they are felled, it is necessary to take into account risks of decay. As a rule in localities of type (*a*) few trees decay before they attain 7 feet in girth and many trees attain girths of 9 feet or over before they begin to decay. But in localities of type (*b*) most of the trees begin to decay before they attain a girth of 7 feet, whilst in localities of types (*c*) and (*d*) decay generally sets in before a girth of 6 feet is attained. These remarks are based on observations of crops which during the greater part of their existence have suffered from frequent fires and other abuses. It is possible or probable that trees grown in crops which are well protected throughout their existence will be liable to decay at comparatively early ages. Decay is greatly helped by slow growth or want of vigour which has in the past often been due to fires, overgrazing and the like.

4. *Methods of treatment of crops grown from seed.*—Like most other kinds of trees sâl produces the best timber when it is grown in forests or complete groups. Though, as has been shown, more or less cover is useful or necessary for the establishment of a crop of sâl saplings, after this stage has been reached cover is generally harmful. In most places groups consisting of about equal aged or equal sized saplings, poles or trees, that is to say, regular groups, are preferable to irregular groups in which the component trees are of widely differing sizes or ages. In regular groups sâl may be grown pure, that is, by itself or mixed with other suitable species. But in either case, to obtain the best possible results, the crop should at all stages be complete without being dense enough to prevent a reasonable development of the crowns of the trees which compose it. So far as is known the density of the canopy should be greater in the earlier stages, that is, till the trees are 2 feet 6 inches or 4 feet in girth, according to the locality, than in the later stages of the crop; for poles or young trees support density better than older trees, and density in the early stages secures the early death and fall of the side branches, and the formation of long boles of clean timber free of knots. It is believed that thinnings of this kind should usually begin when the dominant poles are 1 foot 6 inches to 2 feet in girth, when the number of stems should be 250 to 300 to the acre, and should be continued at intervals of 5 to 15 years till the trees are 4 feet to 5 feet, or 3 feet to 4 feet in girth, according to the locality and the exploitable size or age adopted. From this stage, till the crop is nearly ready for regeneration, it probably pays to give the trees which are expected to form the final crop a greater amount of room; but care should always be exercised

to avoid making large holes in the canopy and encouraging the establishment of a dense undergrowth, such as would greatly interfere with regeneration. So far as can be judged from incomplete observations, the number of stems should be reduced to about 200 to the acre when the trees are 2 feet to 2 feet 6 inches in girth, 60 or 70 to the acre when they are 4 feet to 5 feet in girth and about 40 to the acre when they are 6 feet to 6 feet 6 inches or 7 feet in girth.

The treatment of mixed, regular crops containing a considerable proportion of sâl should be very similar, but in many cases it is desirable that in these thinnings should begin at an earlier stage to prevent the suppression of sâl by inferior species which have a more rapid rate of growth, and the thinnings should always bear on the inferior species rather than on sâl. But the inferior species should not be thinned out to such an extent as to seriously interrupt the canopy.

In short, sâl forests, grown from seed, from which it is desired to obtain the largest possible yield of timber of a high quality, should be managed under the regular method. Actually all sâl forests in Bengal which are managed with a view to the production of large trees are worked under the selection method or under improvement fellings. This is necessary, as the crop is generally mixed and irregular. The supply of large-sized sâl trees is comparatively small and consists of trees scattered throughout the forests, most of the existing trees of large sizes being of species other than sâl, for which there is little demand. In these circumstances attempts to regenerate compact blocks of large sizes would necessitate the cutting of large numbers of trees of inferior kinds, which could not be disposed of, and of immature sâl trees, and would therefore result in serious losses. It is at present sought to improve the crop of sâl by uncovering and keeping free from creepers young growth of sâl wherever found, trees of inferior species which are suppressing sâl being sold if purchasers can be found for them or cut or girdled, and an outturn of sâl timber is in the meantime obtained by the cautious cutting of the largest sized or defective sâl trees in selection or improvement fellings. It is hoped that this treatment will eventually lead in most places to the establishment of more or less regular groups of sâl to which the regular method, or something closely resembling that method, can be applied.

For the selection fellings a minimum exploitable diameter of 2 feet, or girth of 6 feet, has usually been adopted, and the fellings are so regulated that the stock of exploitable trees may be kept up or more than kept up. With fellings so regulated it should not generally be necessary to fell sound trees which are still promising till they are 6 feet 6 inches or 6 feet 9 inches in girth. In some forests, in fact in nearly all localities of types (*c*) and (*d*) and in some localities of type (*b*), there is reason to believe that such a minimum exploitable size will be found to be excessive. Comparatively early decay or an early falling off in the girth increment will probably make it undesirable to attempt to grow in such forests trees with girths exceeding 4 feet, 4 feet 6 inches, or 5 feet as the case may be. But forests of this kind are at present so abnormally stocked that accurate study of their possibilities is impracticable. In the Terai it may eventually be found desirable to raise the minimum exploitable girth to 7 feet or even 7 feet 6 inches.

5. *Coppice.*—So far only the production and treatment of sâl trees which have been raised from seed and are managed with a view to the production of heavy timber have been considered. Besides reproducing itself from seed sâl coppices well, at least outside very damp localities, that is to say, saplings and young trees less than 40 years or so old, when cut within a foot or 6 inches off the ground, send out coppice shoots, which usually leave the parent stem below ground level and rapidly form independent root systems. When a well established seedling, half an inch or so in diameter, is cut back, the resulting shoot grows with only ordinary rapidity, attaining a girth of about 6 inches in 10 years, and is soon indistinguishable from any other seedling, and except that their growth in the first few years is usually more rapid, coppice shoots from the stumps of saplings 1 inch to 2 inches or even 3 inches in diameter are very similar. But coppice shoots from the stumps of poles or small trees up to 8 inches, or in some cases 1 foot in diameter, usually possess characteristics which distinguish them from trees grown from seed throughout their existence. Coppice shoots from such stumps have a very rapid rate of growth to begin with. In the first year they attain heights of 6 feet to 10 feet, and by the time they are 10 years old the leading stems are usually a foot or over in girth. It is believed that from about this point the girth increment falls off to a very marked extent, especially on a poor soil, and so far as is known the period necessary to grow, from coppice, poles about 1 foot 9 inches or 2 feet in girth varies between 20 and 30 years, according to conditions. Coppice shoots of this description do not usually grow into good trees of large size. From the time they attain girths ranging from 2 feet to 4 feet, according

to circumstances, they appear to grow more slowly than seedling trees of equal ages, and they appear to be more subject to early decay than the latter. It was at one time supposed that sâl trees of coppice origin did not produce fertile seed. But this appears to have been a mistake. Reproduction from coppice cannot be utilised to any great extent except in places where the nature of the demand or of the soil, or of the climate makes the production of small poles and firewood the chief object of management. On this account coppice-felling of sâl forests in Bengal is restricted to a few localities where the exploitable age or felling rotations adopted vary between 16 and 30 years. Wherever it has been introduced this kind of management is recent and is actually a conversion of more or less irregular forests into coppice. In these circumstances the forests to which the method is applied are not very suitable for coppicing, sâl trees of the most suitable sizes for coppicing, *i.e.*, 1 foot to 1 foot 6 inches or 2 feet in girth, being comparatively scarce. But seedlings are generally abundant, and though shoots from these seedlings are not likely to attain useful sizes in the first rotation, by the end of it most of them should be capable of putting forth, after they have been cut back, very strong coppice shoots.

Thus, by the end of the second coppice rotation all of these forests should be very well stocked for the application of the coppice system, and the yield of the coppice fellings should show a marked increase.

Accurate observations to show when sâl trees begin to lose the power of coppicing have not been carried out, but there is no reason to suppose that any marked loss of such power occurs before the trees or coppice shoots are 30 years old. When sâl trees instead of being cut at or near ground level are felled so as to leave stumps a foot or more in height, shoots mostly begin on the top of the stump and generally fall when this stump decays.

In the dampest parts of Bengal, *i.e.*, in the Terai and in the Tista valley, sâl is a bad coppicer.

6. *Fire-protection and its results.*—In Bengal fire has been the principal cause of injury to sâl forests; but the effects of fire on sâl differ widely in accordance with local conditions, much depending on the age and condition of the trees, the amount of inflammable material present on the ground and on its relative dryness. In a complete crop of sâl (trees over 2 feet in girth) when there is little inflammable material except a moderate covering of fallen leaves, a single fire can do very little damage, especially if it occurs early in the dry season or when, owing to comparatively recent rain,

the material in question is not at its most inflammable stage. But even under such favourable conditions repeated fires must generally lead to the impoverishment of the soil and to a reduction of the girth increment, and they must also greatly increase risks of premature decay. Where inflammable material abounds a single fire, occurring in the middle of the hot weather, causes lasting injury to all or most of the large-sized trees and kills down to the roots all or most of the small-sized ones. In sâl coppice only one year old, practically all of the shoots are destroyed by almost any fire, and one year's growth is lost. As the coppice grows older its liability to damage from fire decreases, especially if the production of inflammable material is kept down by grazing, fodder-cutting, etc. And usually sâl coppice which is over three years old can, if the production of inflammable material is kept down, be burnt early in the spring, as the leaves fall, without immediate, noticeable injury. Possibly when coppice which is worked for the supply of small sticks or poles, 5 to 10 years old, is burnt in this way the production of wood is not adversely affected. But such burning must nearly always tell severely on the quality and amount of the outturn where it is sought to grow large coppice, 20 to 30 years old. Generally it may be remarked that the effects of fire to some extent depend on local conditions. In fresh situations where the soil is fertile from a forest point of view sâl trees may attain large sizes without becoming unsound, and reproduction may continue in a fashion in spite of frequent fires. Some observers, drawing their deductions from observations of exceptionally well situated areas, have come to the conclusion that fires are not harmful to sâl forests. But the incorrectness of such a conclusion is well-illustrated by the results of a careful examination of the Singhbhum reserves, which was carried out by Mr. Haines from 1902 to 1904. Up to about 1884 these forests had been burnt, whenever they became dry enough to burn, but except in places which had been *jhumed* and in a few relatively small areas which contained particularly good trees, practically nothing had been cut in them before this examination. Fire protection had been attempted between 1884 and 1902, but had not been very successful. Mr. Haines found that out of 442,649 acres:—

(*a*) 20,650 acres, or about 5 per cent., was stocked with well-grown trees or had till recently contained well-grown trees;

(*b*) 32,768 acres, or about 7 per cent., contained a crop of moderately grown sâl trees which were considered to be to a large extent unfit to yield timber for export;

(*c*) 21,192 acres, or about 5 per cent., consisting of areas which had been previously cultivated, contained more or less promising young growth of sâl, of which the establishment had been largely due to partially successful fire-protection in the previous 20 years;

(*d*) 314,303 acres, or 71 per cent., only contained a very scattered crop of ill-formed and more or less unsound sâl trees of great ages but of small or moderate sizes, such advance growth as existed being entirely the result of fire-protection.

In (*a*) resistance to fires has been greater than in other parts of the forests, as the soil is comparatively fertile and as, owing to their greater freshness, areas containing growth of this type were less inflammable than other parts of the forests. Still the crop of sâl found growing on these areas was very far from perfect, and the total amount of sound timber obtained from them has probably not been more than half of the amount they would have yielded if they had been continuously fire-protected. Under fire-protection the reproduction of sâl in these areas has greatly improved, and a promising young growth of sâl is establishing itself in most of the other parts of the forests; and it is already clear that this new crop will be of quite a different class to the original one. In fact, whilst protection from fire is nearly everywhere essential for the development of sâl seedlings into sound, well-formed trees of large sizes, so far as is known fire-protection can only be harmful to sâl in an indirect manner, that is to say, through the help it gives to creepers and other competitors and enemies of sâl.

7. *Competitors of sâl.*—So far as is at present known, the growth of inferior species of trees and creepers, which follows the successful fire-protection of sâl-producing forests which are not completely canopied, is a serious obstacle to the establishment of a young crop of sâl only in places where the rainfall is very heavy, *i.e.*, 100 inches a year or more, or where, though the rainfall is moderate, other conditions are exceptionally favourable to a profuse growth of all kinds of forest plants or weeds. Elsewhere, though the places where creepers do not sooner or later require to be checked appear to be the exception, and the cutting or destruction by other means of trees of inferior species which either dominate young sâl-trees or reproduction of sâl, or take up space in the canopy which is required for the development of the crowns of about equal sized sâl trees, is from time

to time necessary, such operations are of a simple and cheap kind and the necessity of carrying them out is a very minor drawback in comparison with the benefits derived from fire-protection. In the dampest places, that is to say in the Terai, the greater part of the sâl-producing area in the hills of the Darjeeling district, and even in the most fertile valleys in Angul, the profuse growth of trees of inferior species, weeds and creepers which follows successful fire-protection is a very serious obstacle to the reproduction of sâl. Though it is a general rule that in most localities of this description fire-protection in the first instance favours the establishment of reproduction of sâl, after a time, if nothing except fire-protection is attempted, the growth of other plants becomes so profuse that any additional sâl seedlings which come up are choked, and many or most of the sâl saplings or poles which established themselves in the early days of fire-protection succumb to creepers. It is now being sought to ascertain whether the tendency, under continuously successful fire-protection, of the inferior kinds of plants to exterminate sâl in this way can be counteracted by any practicable system of cleaning, weeding and creeper-cutting. The point is to discover whether with the help of such operations, repeated every year till the young sâl is out of danger, the sâl seedlings which still make their appearance in fair numbers can be enabled to grow up into a crop of promising saplings and poles. When a canopied crop, which mainly or entirely consists of such saplings or poles, is formed, the risk of destruction by inferior kinds of trees, weeds and creepers is greatly lessened if it is not altogether removed. Whilst it is admitted by nearly all foresters that if forests of this description are allowed to be burnt indiscriminately, as they were burnt before they were fire-protected, good results cannot be obtained, it is supposed by some that burning might be regulated in such manner as to be made a means of keeping in check the competing plants without permitting the fires to put a stop to the establishment of sâl seedlings and their development into promising poles; and it is possible that experience will prove that this opinion is correct so far as certain descriptions of ground are concerned. But trustworthy experiments in the regulated use of fire to assist the reproduction of sâl have not been carried out, and there is reason to believe that, in the Terai at least, such experiments would not be successful unless they were accompanied by improvement fellings of a more or less arduous and costly nature, whilst they would necessarily lead to a considerable amount of injury to the existing crop of sâl.

Hence in the Terai it is sought to improve the reproduction of sâl by making improvement fellings or cleanings, and weeding the seedlings which are uncovered by, or come up after such fellings every year till they are out of danger. Experiments have not yet gone far enough to show for how many years such weeding will be necessary, but it is supposed that the period will vary between 4 or 5 and 7 or 8 years. Anyhow, the advance growth of sâl which is established by means of such operations will not be out of danger from suppression by weeds and creepers till it forms a canopied crop. In experiments of this description it has been found that suppressed and ill-formed sâl saplings after they are uncovered by the cleanings or improvement fellings take long to recover their vigour, and that it is very difficult to save them from being choked by creepers. In drier climates it is always desirable to cut back such saplings to ground level that they may be replaced by vigorous coppice shoots. But in the Terai they coppice so indifferently that it has not yet been proved to be advantageous to cut them back.

It is possible that continued fire-protection will, by encouraging the growth of competing plants, have the effect of making the reproduction of sâl difficult in many places where up to date fire-protection has been entirely beneficial to this reproduction; and it is desirable that the effects of fire-protection in all sâl forests should be the object of continuous observation, that early steps may be taken to counteract any unfavourable tendencies to which it may give rise.

8. *Creepers.*—In regard to creepers it may be observed that though these pests are at their worst only in the dampest localities, they give more or less trouble in nearly all fire-protected sâl forests, and they also sometimes cause a considerable amount of harm in forests which are not fire-protected. They directly damage seedlings and trees of all sizes by strangling or suppressing them, and they indirectly damage the crop by occupying a larger or smaller proportion of the available space in the canopy. A continuous war must be waged against creepers in nearly all sâl forests. To begin with, it is usually difficult to do more than work over the forests of a Division in the course of a few years cutting creepers which are damaging sâl trees. But when the most urgent work of this kind has been accomplished it is generally desirable to work through the forests again, cutting all large creepers, on whatever trees they may be growing, with the object of helping a dense canopy of trees to form and preventing the seeding of creepers. Nothing checks the growth of creepers more effectively than the formation of a dense

tree canopy. It is not sufficient to cut creepers once. The stumps of the cut creepers usually coppice, or fresh creepers take the places of those which die after being cut, especially in places where the canopy is light or interrupted. Creeper-cutting must generally be repeated at intervals which vary between 3 to 5 years in damp, ten years or more in comparatively dry localities, and it is probable that it will be found necessary to continue the operation at such intervals in most sâl forests in Bengal till they become completely canopied. This is apart from creeper-cutting which may be necessary as part of the weeding or cleaning required to help reproduction or advance growth of sâl in areas which are under regeneration. Such advance growth requires light which also encourages the growth of creepers. Up to the present this growth of creepers in areas which have been partially or wholly cleared for regeneration has been remarkable only in some localities of type (*a*) where it supplies one of the principal arguments for yearly weeding till the young sâl is well established. But it is quite possible that as the soil in other localities improves under protection, the damage occasioned in them by creepers to young sâl will tend to increase.

9. *Grazing.*—So far as is known the grazing of kine and sheep is not directly harmful to sâl except when it is in the small seedling stage, when cattle tread down and destroy, but do not usually eat up, the seedlings. Grazing is indirectly injurious to sâl forests as, when it is heavy enough, it results in the hardening of the soil and a loss of its forest fertility. Though, where other conditions are favourable, considerable numbers of sâl seedlings establish themselves in forests which are lightly or moderately grazed, in heavily grazed forests sâl seedlings are nearly always rare, and where other conditions are unfavourable a moderate amount of grazing may suffice to practically stop the reproduction of sâl from seed. Coppice reproduction of sâl is much less easily damaged by cattle than reproduction from seed and, if the crop which is coppice felled is suitably stocked for the purpose, even heavy grazing does not necessarily prevent the formation of a satisfactory crop of coppice poles. But when a coppice crop is open to grazing from the outset the coppicing of many stumps, which are either too old or too young to coppice vigorously, is nearly always prevented; hence in forests managed under the coppice system which are continuously open to grazing the density of the crop and the production of wood tend to decline. The closure of each coupe for 3 to 6 years, according to circumstances, after its coppice felling, does much to assure the permanency of the crop. But such an amount of closure cannot

everywhere ensure the establishment of sufficient numbers of sâl seedlings for the replacement of stumps which die without coppicing. No experiments appear to have been carried out for determining the effects of the deterioration on the soil, through grazing, on the rate of growth or increment in crops of sâl poles or trees which are too large to be directly injured by cattle. But general observations seem to point to a conclusion that the rate of growth is thereby materially lessened. Usually one of the most serious consequences of grazing is that the practice leads to forest fires, as the herdsmen are often careless, and also as the burning of forest land is generally believed to improve grazing.

10. *Frost.*—Sâl is very sensitive to frost, but fortunately the only sâl forests in Bengal in which severe frosts occur are those of the Palamau and Hazaribagh districts. In these, sâl seedlings which establish themselves in depressions are repeatedly damaged or destroyed down to their roots by frost. Protection by the cover of larger trees sometimes helps to save them from damage. But in exceptionally cold winters, as in 1904-1905, frosts are intense enough to kill or damage small sâl trees which, on such occasions, afford little or no protection to young growth which they dominate. Owing to the repeated destruction of their side branches by frost, the sâl trees in many parts of the Palamau reserves have assumed peculiar and characteristic shapes.

11. *Insect pests.*—The caterpillars or larvæ of several kinds of insects damage sâl either by eating the leaves or by boring into the wood. The temporary loss of leaves from such cause, when it is anything like complete, usually leads to a temporary reduction in the rate of growth. The most common borer generally confines its attention to dead or fallen trees from which the bark has not been removed. But it sometimes attacks and kills green trees.

12. *Artificial reproduction.*—For various reasons this has received very little study. Owing to its rapid germination it is not easy to obtain sâl seed for this purpose, and owing to their long tap root and temperament sâl seedlings are difficult to transplant. Moreover in all the dryer localities, when artificially reproduced sâl can be saved from drying up, it is long before well established seedlings or saplings are produced, and in the damper localities it is difficult to save the seedlings from suppression. For all of these reasons, and as where conditions have been suitable little or no difficulty has been experienced in obtaining sufficient natural reproduction, it has not been thought necessary to give much attention to the artificial reproduction of sâl. But the importance of

the subject will probably increase as the forests develop. The most hopeful experiment made so far is one which was carried out in Puri in 1907, when small baskets, filled with earth, were placed under seed-laden trees, the seed being allowed to fall into and germinate in them. When these seedlings were a few inches high the baskets, with the seedlings in them, were put out in the places it was desired to plant.

13. *Products of sâl trees.*—Sâl is of course chiefly valuable for its timber. But the sap-wood rots rapidly under exposure and is often eaten by insects when it is not exposed, whilst the heart-wood does not display great resistance to exposure, and even when it is not exposed is apt to split and warp badly, unless it is well seasoned before it is put in use. Though the heart-wood of old trees is supposed to be superior in durability to that of young ones, the central parts of old trees which are quite sound are very liable to split in drying, and in sawing logs obtained from very old but sound trees into sleepers or other scantlings it is generally desirable to reject a central wedge 6 inches to 9 inches square at the thick end of the log. Green sâl poles, under 2 feet say in girth, are of very little real use for any purpose, as they contain very little heart-wood; but they are often preferred, especially for mine props, to poles of other kinds, which should prove more durable, probably on account of their straightness. On account of the large amount of sap-wood they usually contain, poles or ballahs from green sâl trees 2 feet 6 inches to 3 feet 6 inches or 4 feet in girth leave much to be desired. But poles or ballahs cut out of dead trees which have lost all their sap-wood but have not stood or lain long enough in the forests to have begun to decay are as a rule of excellent quality.

The quality of the sâl timber produced in the Darjeeling hills and also in the Terai differs considerably from that of the Chota Nagpur and Orissa sâl. The former is rather lighter, splits less, and is generally more durable than the latter. The Darjeeling or Terai sâl cuts into good planks as well as beams, railway sleepers and the like, whilst the Chota Nagpur and Orissa sâl does not usually make good planking. How far this inferiority is due to improper or inadequate seasoning is, however, questionable, for the timber appears to be quite satisfactory for boat-building.

Sâl yields a very good firewood and makes very good charcoal, but it is at present rarely possible in Bengal to dispose of parts of trees which will not yield marketable timber.

The bark of sâl can be used for tanning or for the preparation of tan extracts, but so far it has not been found possible to dispose of bark for such purposes from Bengal forests. The tree also yields a resin in which there was formerly a considerable trade. But as the yield of resin is small, and as the usual method of extracting it is to girdle and kill the trees which are tapped, its collection is not now permitted.

14. The above note contains statements that no doubt require verification, and it is hoped that such will be made by Forest Officers in Bengal. One of the chief objects of the author in writing the note is to draw attention to the lack of knowledge and the large field for enquiry that exists, and to encourage study of the local conditions of growth.

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FOREST RESERVATION IN BURMA IN THE INTERESTS OF AN ENDANGERED WATER-SUPPLY

BY
ALEX RODGER, I.F.S.

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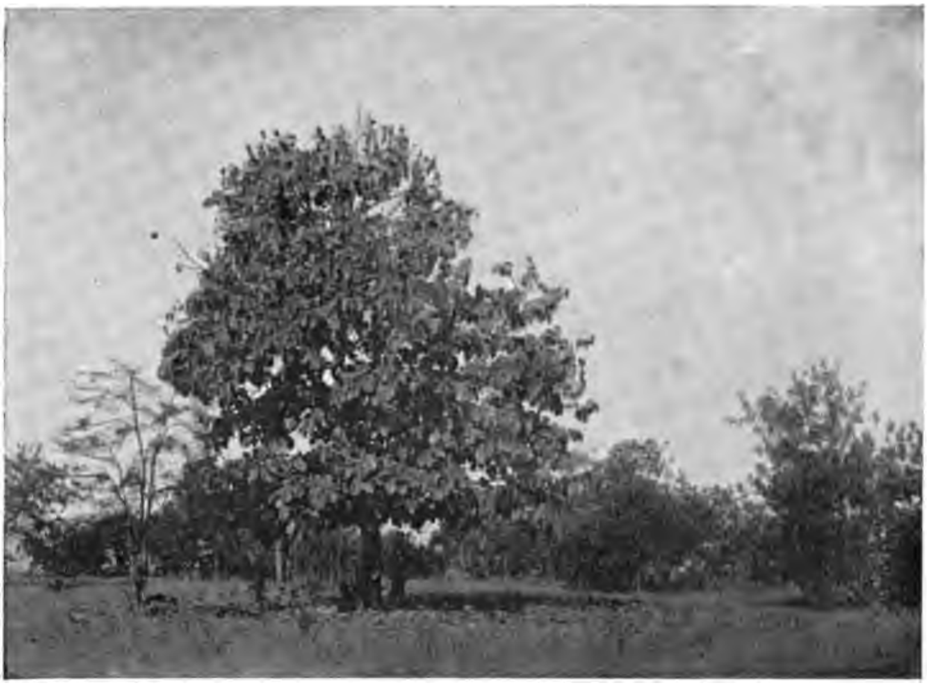

Dipterocarpus tuberculatus being supplanted by *Rhus paniculata, Diospyros burmanica* and *Phyllanthus emblica*. *One Dipterocarpus* tree on left.

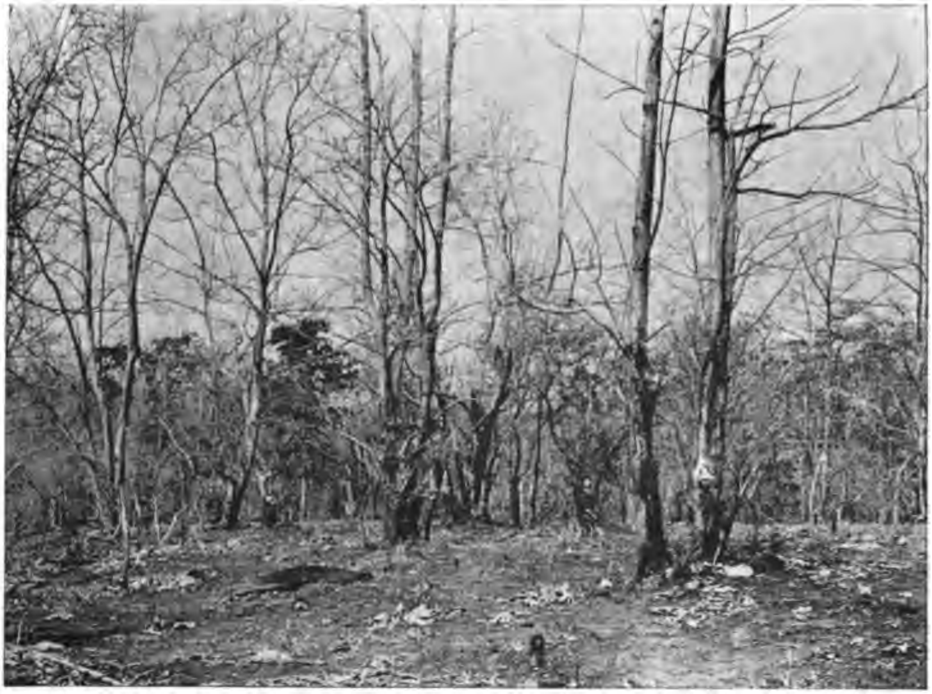

Photo.-Mechl. Dept., Thomason College, Roorkee.

Fig. 2. Teak and *Tectona Hamiltoniana* damaged by dah cutting and burning alongside a *ya* near Myinde Reserve.

FOREST RESERVATION IN BURMA IN THE INTERESTS OF AN ENDANGERED WATER-SUPPLY.

INTRODUCTION.

DURING the season 1904-05 a Forest Officer was put on special duty to examine the forests in the eastern part of the Magwe district and the western part of the Minbu district with instructions regarding "the necessity of protecting forest areas in Magwe and Minbu from further destruction by *taungya* cutters and the advisability of forming more reserved forests in these districts, particularly in the interests of a permanent water-supply which is already endangered."

2. The writer accompanied the Forest Settlement Officer during the camping season of 1907-08, when four of the reserves in the Natmauk township of the Magwe district, proposed by the above-mentioned officer, were being settled, namely, the Pingadaw, Thamyagon, Lower Yin, and Myinde Reserves.

3. Out of a total area of 3,314 square miles in the Magwe district, 399 square miles or 12 per cent. had previously been formed into reserves with the object chiefly of producing timber and increasing the revenue. These reserves all lie along the western slope of the Pegu Yoma, and there were no reserves in the plains at all. The Sun Reserve, shown in the map, is the northernmost of these old reserves.

The following tracts were proposed in 1904-05 for reservation:—

Pingadaw	45 square miles.
Thamyagon	90 " "
Lower Yin	105 " "
Myinde	90 " "
Myothit	85 " "
	415 " "

Only the last, the Myothit tract, 85 square miles, which fringes the older reserves and contains teak and other valuable timbers, was proposed mainly for revenue-paying purposes. The reservation of the remaining four blocks, covering 330 square miles almost entirely in the Natmauk township, was proposed in the interests of the water-supply of various large streams whose waters are largely used for irrigation.

General description of the tract.

4. *Situation.*—The Natmauk township of the Magwe district, in which these four blocks of forest lie, will be seen, on reference to the map which accompanies this paper, to occupy a tract of land approximately 33 miles long and 25 miles broad, and the area is given as 870 square miles.

5. *Configuration.*—The general outline of the country is undulating with a few ranges of hills running more or less north and south. The highest points of these are Thamyagon hill, 1,150 feet; the Natsin hill, 1,289 feet, and the Pingadaw range which has points 1,401, 1,689, 1,419, and 1,576 feet high—all in the western part of the township; the Satkyo hill, 1,766 feet; Nabu hill, 1,520 feet; Hmancheyin hill, 1,699 feet; and Kyaukthalin hill, 1,619 feet, in the eastern part near the Yamethin boundary. West of the Yin stream and south of the Pin stream there are flat valleys of considerable extent, while around the higher hills in the south-east the surface is rough with steep slopes.

6. *Climate.*—The area lies near the southern edge of the dry belt of Upper Burma and the rain-fall is never great. In the year 1907, 33 inches fell at Natmauk. It seems as a rule to be rather more, in this area lying near the hills, than at Magwe on the river bank, where the average fall for the last three years was 32 inches. In March and April the heat is great and the country everywhere extremely bare, except where *Dipterocarpus tuberculatus* trees are plentiful and provide shade some weeks before the rains.

7. *Soil.*—The soil is as a rule very poor. On many ridges in and near the reserves bare gravel and sand are seen, while into the sharply cut hollows which divide the surface a certain amount of sand, and in places fertile soil has been washed. Where these hollows are of fairly large extent, they have been used by the villagers to cultivate *yas* or to plant paddy. The latter will only grow on the best soil, usually along the banks of the larger streams where water is available naturally or by

irrigation in considerable quantity. Laterite does not occur, but there is a considerable area of similar soil and rock in the south-west and south-east.

8. *Population.*—The population of the township at the census of 1901 was 53,262, nearly all Burmans, that is, 61 to the square mile—the area being 870 square miles. The population increased by more than 10,000 between 1891 and 1901, and out of the 53,000 odd, 48,000 were reported to be principally dependent on agriculture.

The area is divided up as follows:—

1. Paddy land	22 square miles.
2. *Ya* land	460 " "
3. Roads, canals, tanks, villages, etc. . .	10 " "
4. Unclassed forest	378 " "
5. Reserved forests	*Nil*
	870 " "

From the above figures it appears that there are three persons to every acre of paddy land, of those principally dependent on agriculture, and six acres of *ya* land to every person.

The principal other industries are cattle-breeding and jaggery-boiling from the juice of the toddy palm, and there are a few salt-boilers. The jaggery-boilers are usually of a poorer class, but most of the villagers keep cattle and depend on the sale of the animals they breed to help to make both ends meet. Large herds are the rule, villages of 100 houses having 2,000 to 5,000 head of cattle, while they have also begun recently to keep goats, which are bought by natives of India who tramp the country for the purpose. The number of cattle in the township was 96,158 in 1905, that is, 112 to the square mile of land available for grazing. Bullocks, cows, and calves total about 89,000, buffaloes about 2,100, and goats about 5,000.

9. *Habits of the cultivators.*—The result of the poverty of this tract of land as a whole and the comparative density of the population, is that the villagers have wandered everywhere to cut the forest and plant up little patches of poor soil, which will only give a crop once in four or five years. After a first inspection of a large patch of forest, a forest officer will believe he has seen a block which may be reserved without difficulty, as it seems to contain a large area of forest, now

mostly of course consisting of scrub, and a few patches of old deserted *ya* land. A reference to the maps of the Land Records Department, however, will assure him that three-quarters of the area is held by the villagers in patches of 5 to 30 acres, either as ancestral property called *Bobabaing*, or as a holding from the State called *Ayadaw*. Over a considerable part of the township the soil is so poor that one man requires up to 10 acres per annum to raise sufficient sessamum, jowar, and ground-nuts to supply him and his family with the means of existence. As most of the ground will not provide a crop unless allowed to lie fallow for four out of every five or six years, it follows that many house-holders are the owners or holders of 50 to 60 or even more acres of fourth-rate *ya* land. In speaking of a holding from the State it must not be understood that land is regularly applied for and handed over to a cultivator by Government officials: a villager has usually established his right as a holder to various pieces of *ya* land simply by going into the tract of forest land assigned to the village and clearing the forest on a patch of it, and continuing to work this patch of land at intervals of four or five years, until his title to the land is admitted by the Settlement Officers. The amount of *ya* land available may thus be seen to be inadequate to properly support the population, as in paragraph 8 it was mentioned that six acres only of *ya* land were available per head. Besides the area sown in the Records of the Land Records Department as "*Ya*" land, there are probably also considerable patches of forest which are worked at long intervals when favourable rainy and ripening seasons offer exceptional chances of getting crops off miserably poor land. With all the help they can get from the sale of their cattle and sundry other small profits, many of the villagers find it necessary to go annually to Lower Burma to cut and cart paddy or do other coolie work, or else cart crude oil from the Yenangyaung oil-fields to villages inland.

It seems to affect them little to see the easier conditions under which the people live in Lower Burma, as they usually return, and even many of their relations, who left the district at the time of the dacoit troubles in 1885—1890 after the annexation, are now returning with the money they have made further south to take up the hard work of coaxing a living from the soil in their own birth-places.

10. *Explanation of a "Ya".*—From the remarks above it will be seen that the word "*ya*" as used in this part of the country has a

different meaning to the word "*taungya*" with which Forest Officers are well acquaintained in Lower Burma.

It is often a tract mapped, marked out, and owned almost as if it was permanent cultivation. It is not properly this, and it cannot be described as temporary shifting hill cultivation. In some parts of the township a "*ya*" is not even shifting, as since ground-nuts have been introduced during the last few years, they have been sown alternately with sessamum on the same land so as to occupy it every year. In this case of course manuring is necessary. A "*ya*" in this part of the country is ordinarily a patch of ground undulating more or less on which such jungle or brushwood as grows is cut and burned: which is then ploughed and sown with such crops as *jowar*, maize, ground-nuts, sessamum, and cotton. The land may be cultivated every year, but much more often it is left fallow for one to ten years.

11. *Description of the Forest: General.*—The aridity and poverty of the soil do not at present allow the growth of good timber anywhere except in the south-east and south-west corners of the township.

The general character of the forest varies with the soil and with the extent to which it has been cut for *yas*, and there are fairly well-marked classes of forest growth which are each characterised by the presence of certain trees. While avoiding any suggestion that these classes of forest exist in well-defined zones, it is possible to divide them roughly as follows:—

1. True *Indaing*.
2. Scrub *Indaing*.
3. Cutch forest.
4. *Than* and *Dahat* forest.
5. Forest in the hollows.
6. Thorny thickets.

(1) *True Indaing* occupies a small area in the south-east and another in the south-west. The latter now produces few trees of large size, as it has been much cut over, formerly mostly to provide house posts and poles for use in all kinds of temporary sheds and barns and for village fences, and latterly largely to clear the ground to grow ground-nuts which flourish in the reddish soil usually found in this part of the country in Indaing. The rock

underneath is not laterite but apparently the soil has similar properties. In the south-east there is a considerable area of the old *Indaing* left, bearing many trees of good growth. The principal of these are—

In (*Dipterocarpus tuberculatus*) *Ingyin* (*Pentacme suavis*), *Thitya* (*Shorea obtusa*), *Lon* (*Buchanania latifolia*), *Taukkyan* (*Terminalia tomentosa*), *Tè* (*Diospyros burmanica*). *Pyinma* (*Lagerstrœmia Flos Reginæ*) and *Pyingado* (*Xylia dolabriformis*) are found, but are small and crooked.

(2) *Scrub Indaing* occupies a large part of the area, especially in and near the Palanbin Reserve and along the eastern boundary of the township. The soil is often pure sand, with plentiful blocks of sandstone and *Ingyinkyauk* (fossilised wood). Many of the ridges consist of a very poor sandy gravel.

All the trees are poor and stunted. Of many species which occur the principal are: *Diospyros burmanica, Terminalia tomentosa, Pentacme suavis, Dipterocarpus tuberculatus, Buchanania latifolia, Sideroxylon tomentosum,* and *Phyllanthus Emblica.* The undergrowth consists of large patches of *Hiptage candicans* and *Rhus paniculata* with a great deal of small stunted palm (*Phœnix acaulis*). *Hiptage candicans,* and *Rhus paniculata* gradually occupy large areas of this forest when the larger trees have been killed by continued cutting and burning. This forest is called, as a rule, by the Burmans *Kyauktaw* and is less adapted for *ya* cutting than any other.

(3) *Cutch forest* occupies all the barest ridges and slopes where it is possible to make clearings for cultivation. Being extremely difficult to kill it comes up again and again and covers many square miles of *ya* land which is resting. Forming an open, scattered scrub on these situations, it is associated, as a rule, with *Morinda tinctoria, Boscia variabilis, Capparis flavicans, Capparis grandis, Dalbergia paniculata, Acacia leucophlœa,* various species of *Gardenia, Zizyphus jujuba, Diospyros burmanica, Hiptage candicans, Rhus paniculata,* and several creepers belonging to the genus *Capparis.* Cutch, *Morinda tinctoria, Bauhinia racemosa,* and *Dalbergia paniculata* form in many places an even-aged brushwood among which older trees of *Boscia*

variabilis, *Acacia leucophlœa* and *Capparis flavicans* are very characteristic objects. The *Boscia* and *Capparis* are more frequently left than other species on account of their uselessness for any purpose, but they are of course much damaged by fire.

This forest and that under the following heading cover most of the *ya* land in the township.

(4) *Than* and *Dahat* forest is chosen as a name for a class of forest which is very widely distributed, both on ridges where the trees are often stunted, and in hollows where they grow much better.

With *Terminalia Oliveri* and *Tectona Hamiltoniana* occur *Balanites Roxburghii*, *Heterophragma sulfureum*, *Anogeissus acuminata*, *Pterocarpus macrocarpus*, *Dalbergia paniculata*, *Albizzia Lebbek*, *Cutch*, *Acacia leucophlœa*, *Terminalia tomentosa*, *Flacourtia cataphracta*, *Bombax insigne*, *Odina Wodier*, *Millettia Brandisiana*, *Butea frondosa*, two species of *Morinda*, *Diospyros burmanica*, *Strychnos Nux-vomica* and several Euphorbias. As undergrowth *Rhus paniculata* and *Hiptage candicans* appear again, and there is a little *Dendrocalamus strictus*. Owing to fire and grazing the ground under this forest may often be found in the hot weather perfectly bare, and sometimes as smooth as a tennis court.

Good forest of this class, with plenty of *Dendrocalamus strictus* bamboo, occurs over about 5 square miles in the south of the Myindè Reserve, adjoining the old Sinthè and Sun Reserves. This area has escaped up to date owing to its distance from villages, but *ya* cutting has now begun, and reservation took place just in time to save some good forest.

(5) *The forest in the hollows* has evidently been favoured both by nature, the soil being more fertile and damper, and by man, many of the slopes on which the trees grow being ill-adapted for dragging logs or cutting *yas*. In addition to many of the species found in the forest last described, several species of *Dalbergia*, *Millettia*, *Albizzia*, *Eugenia*, and *Dolichandrone* occur, as well as *Schleichera trijuga*, *Erythrina suberosa*, *Garuga pinnata*, *Bauhinia variegata*, *Lagerstrœmia tomentosa*, *Holoptelea integrifolia*. The area occupied by these strips of forest is not

large, but a considerable number of species are found, and the growth is usually fair. *Dendrocalamus strictus* is not uncommon. It looks as if some of the more delicate species, being unable to survive the constant assaults to which they are subjected on the ridges, have retreated to the hollows.

(6) *Thorny thickets.*—Along many of the large streams are flat low-lying lands which have been cultivated as *yas* for many years. Almost all the trees have disappeared from these areas, and their place has been taken by *Zizyphus jujuba.* This species also occurs in the more fertile of the higher lying *ya* lands, often without admixture. In the thickets it is frequently associated with creepers and also with some small trees such as *Holarrhena antidysenterica* and *Ehretia lævis. Bombax malabaricum* is a common object on these flats, often growing to a very large size.

The occurrence of some of the species found is very local. Teak is fairly plentiful in the west, but is almost entirely confined to the edges of paddy fields where it has suffered much ill-usage and is now of little value, most of the trees having grown from stools and many of them being unsound. *Melanorrhœa usitata* was found only on a very confined area on the edge of the Palanbin Reserve. *Tamarix dioica* and *Bambusa Tulda,* were each found only once, and *Melia Azadirachta* was not seen in the western half of the area at all. *Acacia ferruginea* (?) was only found in the extreme north-east. A number of other species seemed to be very rare.

Some idea of the characteristics of the forest will be gathered from the photographs, which indicate, correctly, that the greater part is nothing but scrub.

12. *Natural Regeneration.*—If it is desired to protect any large area of the head-waters of the Yin Chaung in future, the question as to how soon it would become covered with natural forest is important. In the real *Indaing, Dipterocarpus tuberculatus,* as usual, is able to produce a plentiful crop of young stems from seed and from the stumps of the young trees which have been cut wholesale.

In the Cutch forest, Cutch and *Morinda* are both able to send up powerful young shoots from stumps to any extent and cover the ground

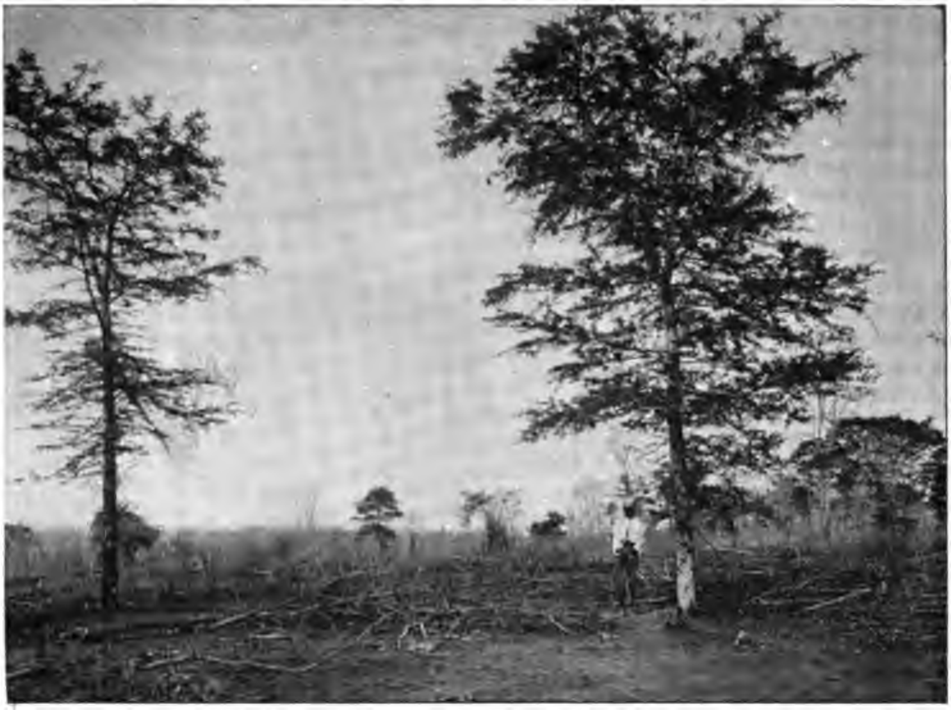

Fig. 3. Freshly cut *ya* in Cutch scrub jungle.

Acacia leucophlea poles left to be burnt standing to save the trouble of felling.

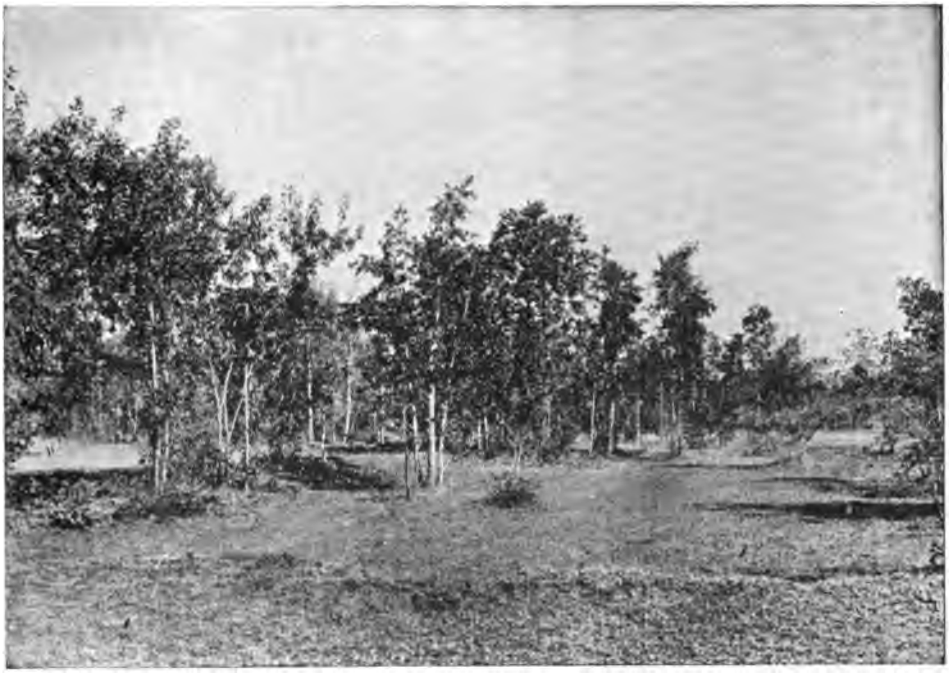

Photo.-Mechl. Dept., Thomason College, Roorkee.

Fig. 4. Growth of *Diospyros burmanica* on fields left unworked for four years.

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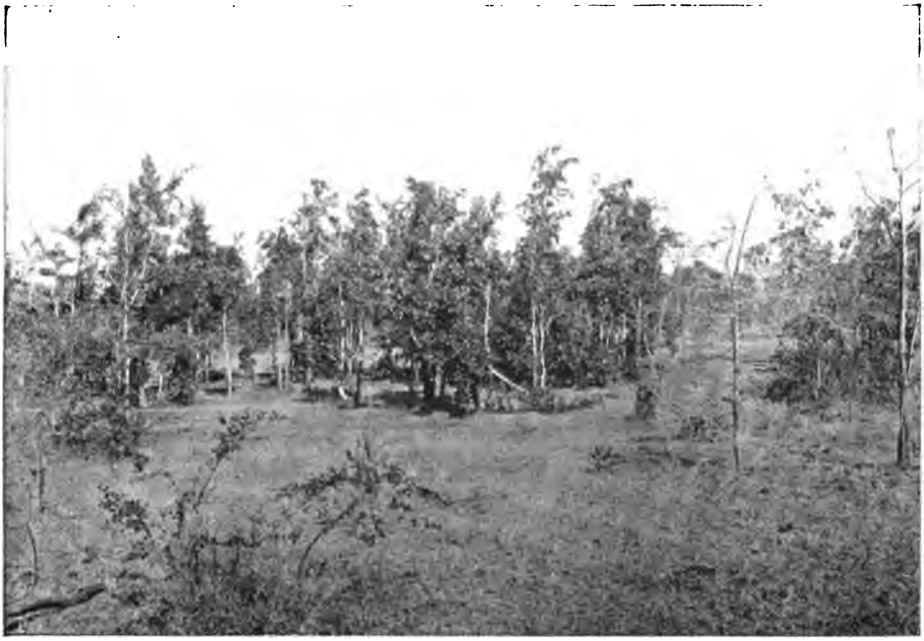

Fig. 5. Growth of *Diospyros burmanica* in groups—the result of root shoots.

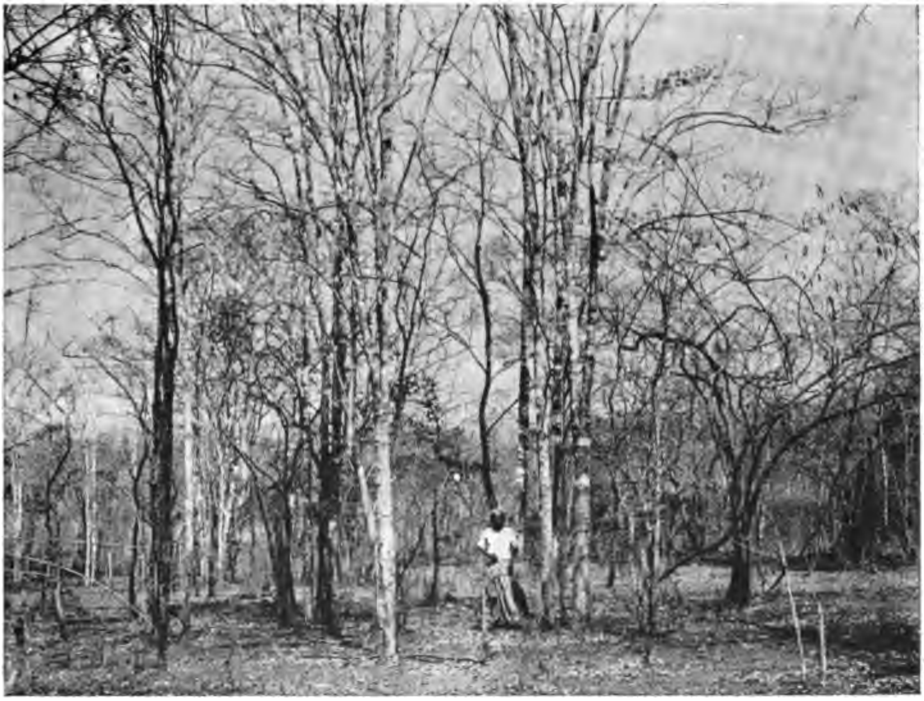

Photo.-Mechl. Dept., Thomason College, Roorkee.

Fig. 6. Natural regeneration of Cutch and *Dalbergia paniculata*, about 12 years old, on old *ya* land.

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amply in five years. In the *Than* and *Dahat* forest, regeneration from seed is good and *Diospyros burmanica, Tectona Hamiltoniana, Dalbergia paniculata, Heterophragma sulfureum, Millettia Brandisiana, Bombax insigne,* and others send up powerful stool-shoots. In spite of the continual hacking with *dahs* to which these trees are subjected they preserve their vitality in a very marked degree, so that a *ya* left for a few years becomes covered with forest without much difficulty.

Zizyphus jujuba is also able to produce thick cover in a few years, but may be otherwise regarded as a weed rather than a tree. *Rhus paniculata* and *Hiptage candicans* are also very useful in this way, but are very little better as wood-producers.

The scrub *Indaing* forest is not in the same happy condition. Some old *yas* which were seen in the Pettaw Reserve, deserted since the dacoit troubles in 1885—1890, when many villages were abandoned, are still extremely bare. The old stumps have produced a sparse growth of poles of *Diospyros, Terminalia, Sideroxylon,* etc., about six inches in diameter, but between them are spaces of considerable extent, perfectly bare after the annual fires. Protection from fire and grazing would probably produce a crop of seedlings in time, but the process must be slow as the soil has been much exhausted.

It is in this class of forest that the evil effects of fire and grazing are principally seen.

13. *Relative requirements of the species found.*—The poorness of soil and dryness over the tract under report do not permit of many of the trees growing to their best state, but in the following list the more important species have been classified in four classes according to the requirements they seem to make on fertility and moisture in the soil, according to the observations made in the Natmauk township: class I making most demand.

Class I.—Bombax malabaricum, Schleichera trijuga, Xylia dolabriformis, Lagerstrœmia Flos Reginæ, Teak.

Class II.—Miliusa velutina, Sterculia (3 species), *Berrya Ammonilla, Feronia Elephantum, Garuga pinnata, Chukrasia velutina, Lophopetalum Wallichii, Dalbergia cultrata* and *D. Oliveri, Padauk, Millettia pulchra* and *M. pendula, Butea frondosa, Erythrina suberosa, Bauhinia variegata, Albizzia stipulata* and *A. procera, Terminalia Chebula, T. pyrifolia* and *T. tomentosa, Eugenia* (2 species), *Careya arborea, Legerstræmia tomentosa, Gardenia obtusifolia, Diospyros ehretioides* and

D. montana, Holarrhena antidysenterica (*Codaga*), *Cordia Myxa, Dolichandrone* (3 species), *Heterophragma adenophyllum, Ficus* (4 species), *Holoptelea integrifolia, Bambusa Tulda.*

Class III.—Dillenia parviflora, Flacourtia cataphracta, Dipterocarpus tuberculatus, Shorea obtusa, Pentacme suavis, Bombax insigne, Grewia lævigata, Azadirachta indica, Zizyphus jujuba, Odina Wodier, Millettia Brandisiana, Butea superba and *B. parviflora, Cassia renigera, Acacia leucophlæa, Albizzia Lebbek* and *A. lucida, Terminalia Oliveri, Anogeissus acuminata, Gardenia sessiliflora* and *G. erythroclada, Diospyros burmanica, Strychnos Nux-vomica, Ehretia lævis, Heterophragma sulfureum, Tectona Hamiltoniana, Phyllanthus* (2 species), *Euphorbia* (3 species), *Dendrocalamus strictus.*

Class. IV.—Boscia variabilis, Capparis (6 species), *Hiptage* (2 species), *Balanites Roxburghii, Buchanania* (2 species), *Rhus paniculata, Bauhinia racemosa, Acacia Catechu, Gardenia turgida, Phœnix acaulis.*

PROGRESS OF RESERVATION DURING 1907-08.

14. *Objects to be attained.*—A reference to the map which accompanies this paper shows that the greater part of the area is drained by the Yin Chaung, and the most important object to be attained was the protection of the head-waters of this stream so as to prevent the wasting of the water by the sudden rushes, followed by long periods of low water or drought which at present prevail. Much land is irrigated by the water of the Yin Chaung and its tributaries, and this all suffers when the water-supply is irregular and uncontrollable. In the southern part of the township the Yin Chaung extends into a broad shallow sandy bed, but a feature of the country is the way in which its main tributaries dwindle rapidly in breadth as one ascends their channels. The Yin Chaung drains in the Natmauk township an area of 570 square miles and a further area of 42 square miles in the Yamethin district. The following note was made by the officer who proposed the reserves :—*In an ordinary year there is sufficient supply of water in the Yin river to feed all the canals which take off from it ; but rising in a poor tract and flowing for many miles through a poor country its waters are not charged with rich deposits like those of the smaller streams which have their catchment area in the forest reserves. Of the feeders of the Yin only those are valued which come from the east rising in the forest clad hills, they contain a fairly constant supply of water in the rains, and their waters are rich in*

silt. Those which join it from the west are mere torrents holding water only during and immediately after rain, and coming from a sandy treeless region their waters are charged with barren sand and contain no fertilizing matter. Several minor canals have been abandoned, because the people allege that the streams which fed them and brought "Golden water" to the fields have become unmanageable torrents whose sand-charged waters now impoverish the soil.

The Pin Chaung, which forms the northern boundary of the Magwe district for some distance, is not so dependent on this township for its drainage as this only extends to 300 square miles within the Natmauk township, and a large part of its basin lies in the Myingyan district. Nearly all the real head-waters of the Yin Chaung, on the contrary, are contained within the township and the adjoining area in the Yamethin district.

Besides the protection of the forest for climatic reasons, it was desired also to assure a certain area of forest for the timber and firewood supply of the township in future years.

15. *Hindrances to Reservation.*—Almost without exception the population of the township was opposed to reservation. It was felt as usual that Government were taking their lands from them to form a reserve for the benefit of Government, the villagers' interests being neglected.

Explanations designed to confute this view were of little avail. Not one man in a hundred would agree that the water-supply would be altered by reserving tracts of forests on the hills, and they preferred to buy the house-building timber that has been wasted for so many years by *ya*-cutters, rather than have their *ya* lands made into timber forests. The objections may be grouped as follows :—

(*a*) Curtailment of *ya*-cutting land.
(*b*) Curtailment of grazing land.
(*c*) Prohibition of tree cutting for house-building, agricultural purposes, and firewood for domestic use, toddy-boiling and salt-boiling, and extraction of fruits, leaves, etc., for food.

(*a*) It has been explained above how many of the people are unable to get more than a scanty living from such *ya* land as they own or work. The curtailment of this land was felt to be a great grievance and the reserves had to be selected in the places where there were fewest *yas*. In the whole township it was impossible to select an area of one square mile, with sides measuring a mile each way, in which several *yas* were not included. In some cases considerable areas of land belonged to one man, the present representative of an old family of hereditary village headmen. He had, as a rule, as tenants of a sort many of the poorer villagers who held the land under a sort of mortgage from him, and on these men the settlement will be particularly hard because they can only receive a part of the Government compensation money, though they were in all but name owners of the *ya* land they had been working. There is no doubt that a number of villagers will have to leave the township when the forests are gazetted as reserves.

(*b*) In December 1904 the Conservator of Forests suggested that measures should be taken to restrict the keeping of large herds of cattle for sale in this part of Burma, on the following grounds:—

(I) The denudation of stream catchment areas caused by cattle, especially in the Yin Chaung drainage.
(II) Deterioration of the breed caused by the insufficient grazing for large herds.
(III) The large herds kept for sale would finally destroy the village grazing grounds.
(IV) Forest subordinates were unable to impound cattle in reserves as they always run away: and they frequently trespass in reserves. It was proposed to take action under the Forest Act to—

1. Fix the number of cattle required in each village for agricultural purposes and a certain number above;
2. Levy grazing fees on all other cattle;
3. Insist that cattle grazing within five miles of a reserve should be watched by a herdsman, and fine a village as a whole for illicit grazing.

The Commissioner after consulting the Deputy Commissioners in the neighbouring dry zone districts was unable to agree to these proposals. He found that cattle breeding was a necessary adjunct to cultivation in the dry zone; that the manner of raising cattle may make them stunted, but also hardy and useful; that the cattle manure was most useful and in many cases a necessity; that villagers should not be fined in this general way; and the Forest Department, already undermanned, would not be able to enforce the proposed regulations. Goats, however, were banned as being unnecessary, extremely destructive, and until recently, seldom kept by the Burmans.

The Local Government agreed to this.

After a tour through the township, it is difficult to take exception to this decision. The people as a whole are poor, they depend largely on their cattle, and the writer is of opinion that the damage they do to the forests is not greater than must be tolerated under the circumstances, putting goats outside the question.

The number of species that cattle will eat does not appear to be very large, and in some parts, pure *Indaing* for example, they eat very little. The species they eat most appear to be *Acacia leucophlœa, Millettia Brandisiana, Morinda* (dry leaves) cutch, *Terminalia Oliveri, Dalbergia paniculata, Flacourtia cataphracta, Terminalia tomentosa, Rhus paniculata, Hiptage candicans, Boscia variabilis, Grewia lævigata, Odina Wodier, Albizzia Lebbek, Diospyros burmanica, Capparis flavicans* (fruit), *Sterculia fœtida, Bauhinia racemosa.* There is no doubt that when damage by *ya*-cutters, pole-cutters, and fire is stopped, the forests will recover in spite of grazing. The areas now reserved are naturally the farthest from the villages available, and to some of them the cattle rarely penetrate. From December till June they graze on the paddy lands, old clearings and *ya* lands, and it is during the rest of the year that they graze principally in the forests. It is noteworthy that when *Diospyros burmanica,* for example, is left alone by the *ya* and pole-cutters, it succeeds in producing a crop of poles by means of root-shoots, although it may be growing in the middle of grazing grounds and it is one of the species eaten. It is also one of the most plentiful in the township.

(*c*) The prohibition of all tree cutting in the reserves was an absolute necessity. The damage done by the Burman villager with his *dah* to growing forests is almost incalculable. Apart from *ya*-cutting, trees are chipped and hacked, pollarded, and felled everywhere, and when felled are utilised in the most wasteful way. Young poles are cut and burned or used in the villages until it seems marvellous that there is anything left on the ground. Petitions were invariably put in for house-building timber and firewood, but no rights of this description were given, except in the case of a few salt-boilers near the Myingyan boundary who were allowed to cut dead timber for their trade. Round the large areas of proposed forest which could not be reserved owing to the numerous *yas* are belts of jungle from which sufficient timber and firewood can be obtained until the reserves can recover a little. The villagers usually declared that these patches of jungle would not give them enough timber and firewood, but it is a question of deciding, especially considering the growing population, whether they should have enough, of firewood at any rate, now, and nothing later, or a restricted supply now and plenty of timber and firewood later.

The timbers which they use mostly, when they can get them, are:—

House-posts.—Pentacme suavis, Shorea obtusa, Dipterocarpus tuberculatus, Xylia dolabriformis, Terminalia tomentosa. They also use the following of necessity:—*Morinda, Sideroxylon tomentosum, Acacia leucophlœa, Buchanania latifolia, Dalbergia cultrata,* which are said to last about a year, and *Terminalia Oliveri* and *Diospyros burmanica,* which may last two years.

Planks.—Heterophragma sulfureum, Bombax insigne, Hymenodictyon excelsum, Dipterocarpus tuberculatus, Diospyros burmanica.

The following list of minor forest products used for food may also be of interest:—

Young leaves.—Buchanania latifolia, Cordia Myxa, Ficus Cunia, Azadirachta indica, Ventilago madraspatana, Cratæva Roxburghii, Aganosma marginata.

Fruit.—Diospyros burmanica, Buchanania latifolia, Phyllanthus Emblica, Zizyphus jujuba, Terminalia Chebula, Eugenia jambolana, Bauhinia malabarica, Carissa spinarum, Grewia lævigata, Ficus glomerata, Feronia Elephantum, Holarrhena antidysenterica, Cratæva Roxburghii, Oroxylum indicum.

16. *Results of the Forest Settlement.*—From the above description it will be readily imagined that reservation was difficult, and that only a small part of the area proposed could be actually reserved. In some cases large areas had to be thrown out as it was found that they were full of paddy-land in large and small blocks which it was impossible to buy or demarcate out. A few patches of paddy-land were demarcated out from the body of the reserves when it was found impracticable to buy them, especially as in many cases the amount which could be paid in compensation would have been very far from fully compensating the owner for the loss of the land, in a district where paddy-land is so scarce.

The following rates were paid as compensation for *ya* lands taken up:—

	R
3rd class private holdings	10 per acre.
4th ,, ,, ,, ...	6 ,, ,,
3rd ,, holdings from the State . . .	2 ,, ,,
4th ,, ,, ,, ,, . . .	1 ,, ,,

These last two items are the same as two years' revenue.

In the following table are shown the area of each reserve as proposed, the area of each reserve as settled, and the amount to be paid as compensation.

Reserve as proposed.	Area in square miles.	Reserve settled.	Area in square miles.	Cost.
				R
Myothit . . .	10	1. Gwebin . .	3	500
		2. Kyadu . .	2	500
	10		5	1,000
Thamyagon . .	85	3. Palanbin . .	25	32,000
		4. Tègyi . .	10	2,000
	85		35	34,000
Pingadaw . . .	46	5. Pingadaw . .	21	12,000
Lower Yin . . .	105	6. Pettaw . .	15	6,000
		7. Satkyodaung .	10	4,000
		8. Sainggaung .	12	3,500
	105		37	13,500
Myinde . . .	90	9. Myinde . .	32	3,000
TOTAL .	335		130	63,500

Note.—Only a small part of the proposed Myothit Reserve and about half of the settled Gwebin Reserve are in the Natmauk township: all except a small part of the proposed Thamyagon Reserve was inside the Natmauk township. These parts only are shown in the above table. The amount of R32,000 includes a considerable sum as compensation for turning out the villages of the Palanbin.

It was found necessary to give grazing rights over large areas in the reserves as they often came close up to villages. No other rights were given except to cut bamboos and thatching grass which are of little importance. Thus in order to make 130 square miles of reserved forest Government must pay R63,500 or R488 per square mile. In view of the extraordinary difficulty and urgency of reservation, this sum, though large, cannot be regarded as excessive. If the area were in one block, it would doubtless be very useful as a protection against denudation, but as it is, it is probable that the separate blocks will be more useful as timber and fuel reserves. Gwebin, Kyadu, and Tègyi especially will be useful in this way and of little use as protection of the Yin drainage. The other six blocks lie more on the hills round the sources of the streams, but Pingadaw is unfortunately only a long narrow strip.

The following are approximately the areas which fall within the drainage of the Yin Chaung in the township:—

	Square miles.
Kyadu	2
Gwebin	3
Palanbin	25
Tègyi	3
Pingadaw	10
Pettaw	1
Satkyodaung	10
Sainggaung	12
Myinde	32
	98

This will result in 17 per cent. of the Yin Chaung drainage in the township being covered by reserved forest.

Conclusion.

17. As the settlement failed to form several large blocks of forest to protect the head-waters of the Yin Chaung, it remains to be seen what further steps can be taken. Prevention of *ya* cutting in the forests

under Rule 19 made under the Burma Forest Act, 1902, without making reserves, may be dismissed as impracticable, because every acre of land that can produce paddy is already made to do so, and *yas* are a necessity. Considering the area of the Yin Chaung drainage which lies within the Yamethin district, we have 42 square miles in which are 21 villages which all cut *yas* and own large herds of cattle. Their land does not suffice for them, and numbers of them come over to cut *yas* and graze their cattle in the Natmauk township. They have also a good deal of paddy-land. It would therefore be a very serious and costly undertaking to turn them out and attempt to make the 42 square miles into reserved forest. As a continuation of this block of forest it would be possible to acquire a large block of country, say east of a line running due north from the north-east corner of the Gwebin Reserve to the Yin Chaung watershed. A large number of villages could be broken up and only those people left who could live on the paddy-land, the whole area made into a reserve and the paddy-land demarcated out. This area, including the 42 square miles in Yamethin, would cover about 310 square miles.

These heroic and extremely expensive measures appear to be the only way in which the Yin Chaung drainage can be properly protected. The people could be taken to the new land being opened out along canals in Upper Burma, though they would strongly object to any such procedure. It would, however, be very unfair to prevent them cutting *yas* and leave them to find some other way of living without adequate compensation.

APPENDIX.

List of species found in the Natmauk township.

Note.—In the following list a number of the local Burmese names differ from those given in the official "List of Burmese Names of Trees and Plants," and there are also some which do not seem to have been recorded before.

Natural order.	Scientific name.	Burmese name.	Month in which flowers were collected.	REMARKS.
Dilleniaceæ	Dillenia parviflora	Linyaw	...	
Anonaceæ	Miliusa velutina	Thabut	March	Rare.
Capparidaceæ	Boscia variabilis	Thahmon	January.	
	Capparis horrida	Nwamanithaubyet	March.	
	„ crassifolia	Subauknwe	„	
	„ polymorpha	Nwamanithaubyet	„	
	„ flavicans	Saungkyan	„	
	„ grandis	Kaukkwe	„	
	„ glauca	„	„	
	Cratæva Roxburghii	Kadet	April	Rare.
Bixaceæ	Flacourtia cataphracta	Naywe	February.	
Tamariscaceæ	Tamarix dioica	Gyogyi	...	Rare.
Dipterocarpaceæ	Dipterocarpus tuberculatus	In	April.	
	Pentacme suavis	Ingyin	March.	
	Shorea obtusa	Thitya	April.	
Malvaceæ	Bombax malabaricum	Letpan	February.	
	„ insigne	Didok	March.	

List of species found in the Natmauk township—contd.

Natural order.	Scientific name.	Burmese name.	Month in which flowers were collected.	Remarks.
Sterculiaceæ	Sterculia fœtida	Letkok	March	Rare.
	„ versicolor	Shawbyu	February	„
	„ colorata	Wetahaw	March.	
Tiliaceæ	Berrya Ammonilla	Petwun	...	Rare.
	Grewia lævigata	Tayaw	...	
Malpighiaceæ	Hiptage madablota „ candicans	Zani	January.	
		Zamani	„	
		Zipalan	...	
		Benwè	...	
Rutaceæ	Feronia Elephantum	Thi	April	Rare.
Simarubaceæ	Balanites Roxburghii	Salwe	April.	
		Subalwe	„	
Burseraceæ	Garuga pinnata	Chinyok	March.	
Meliaceæ	Azadirachta indica	Tama	March.	
	Chukrasia velutina	Yinma	...	
Celastraceæ	Lophopetalum Wallichii	Mondaing	January.	
Rhamnaceæ	Ventilago madraspatana	Tayawnyonnwè	...	
	Zizyphus jujuba	Zi	...	
Ampelideæ	Vitis repanda	Hlesanwè	March.	

List of species found in the Natmauk township—contd.

Natural order.	Scientific name.	Burmese name.	Month in which flowers were collected.	REMARKS.
Sapindaceæ .	Schleichera trijuga . .	Gyo . .	March.	
Anacardiaceæ .	Rhus paniculata . .	Kaunggale . Pyizin . .	... ...	
	Odina Wodier . .	Nabe . .	February.	
	Spondias mangifera .	Gwe . .	...	
	Melanorrhœa usitata .	Thitsi . .	January	Rare.
	Buchanania latifolia .	Lon . .	...	
	Buchanania glabra? .	Lonbo . .	...	
Leguminosæ—				
1. Papilionaceæ	Millettia pendula . .	Thinwinpaukbyu	March.	
	„ Brandisiana .	Pingan . .	„	
	„ pulchra . .	Thitpagan . Thinwinzat .	„ „	
	Erythrina suberosa .	Kathit . .	„	
	Spatholobus Roxburghii .	Pauknwe . .	April.	
	Butea frondosa . .	Pauk . .	February.	
	„ superba . .	Pauknwè . .	„	
	Dalbergia cultrata . .	Yindeik . .	March.	
	„ paniculata .	Tabauk . .	April.	
	„ Oliveri . .	Tamalan . .	March.	
	Pterocarpus macrocarpus .	Padauk . .	April.	

List of species found in the Natmauk township—contd.

Natural order.	Scientific name.	Burmese name.	Month in which flowers were collected.	REMARKS.
2. Cæsalpinieæ	Cassia renigera	Nguzat	April.	
	Bauhinia racemosa	Palan	March.	
	„ malabarica?	Chinbyit	...	
	„ diphylla?	Kalannwe	...	
	„ variegata	Palanbyu	February.	
3. Mimoseæ	Xylia dolabriformis	Pyin	February.	
	Acacia leucophlœa	Tanaung	...	
	„ ferruginea?	Tanaungsubyu	...	Rare.
	„ Catechu	Sha	...	
	Albizzia lucida	Thandat	April.	
	„ procera	Sit	...	Rare.
	„ Lebbek	Kokko	March	
	„ stipulata	Bonmeza	...	
Combretaceæ	Terminalia Chebula	Panga	...	
	„ pyrifolia	Lein	...	Rare.
	„ tomentosa	Taukkyan	...	
	„ Oliveri	Than	...	
	Anogeissus acuminata	Yon	February.	
Myrtaceæ	Eugenia jambolana	Thabyebyu	January.	
	„ sp.	Konthabye	...	
	Careya arborea	Banbwe	March.	Rare.

List of species found in the Natmauk township—contd.

Natural order.	Scientific name.	Burmese name.	Month in which flowers were collected.	REMARKS.
Lythraceæ	Lagerstrœmia tomentosa	Leza	April.	
		Zaungbalwe	"	
	" Flos Reginæ	Pyinma	"	
Rubiaceæ	Adina cordifolia	Hnaw	...	
	Stephegyne parvifolia	Tein	...	
	" diversifolia	Binga	...	
	Hymenodictyon excelsum	Kusan	...	Rare.
	Gardenia obtusifolia	Yingat	March.	
	" turgida	Thaminsani	"	
	" sessiliflora	Thaminsabyu	...	
	" erythroclada	Hmanni	...	
	Morinda tinctoria	Nibase	March.	
	" tomentosa			
Sapotaceæ	Sideroxylon tomentosum	Thitcho	...	
Ebenaceæ	Diospyros ehretioides	Aukchinsa	...	
	" montana	Chok	March.	Rare.
	" burmanica	Tè	"	
Apocynaceæ	Carissa spinarum	Kanzat	March.	
	Holarrhena antidysenterica	Lettok	"	
	Wrightia tomentosa	"	April.	
	Vallaris dichotoma	Tabunwe	March.	
	Aganosma marginata	Kaungnwe	April.	

List of species found in the Natmauk township—contd.

Natural order.	Scientific name.	Burmese name.	Month in which flowers were collected.	REMARKS.
Loganiaceæ .	Strychnos Nux-vomica .	Kabaung . .	March.	
Borraginaceæ .	Cordia Myxa . . .	Thanat . .	March.	
	Ehretia lævis . . .	Odein . .	February.	
		Tawgon . .	,,	
Bignoniaceæ .	Dolichandrone stipulata .	Mahlwa . .	January.	
	,, Rheedii .	Hingutpo .	April.	
	,, velutina? .	Hingut . .	March.	
	Heterophragma adenophyllum.	Petthan . .	February.	
	Heterophragma sulfureum	Kyunbo . .	,,	
	Stereospermum neuranthum.	Thande . .	...	
	Oroxylum indicum . .	Kyaungya .	...	
Verbenaceæ .	Vitex limonifolia . .	Kyetyo . .	...	
	Tectona grandis . .	Kyun . .	...	
	,, Hamiltoniana .	Dahat . .	April.	
Euphorbiaceæ .	Euphorbia antiquorum .	Tazaungpyathat.	March.	
	,, neriifolia .	Tazaunggyi .	,,	
	,, Nivulia .	Tazaungmyinna.	,,	
	Phyllanthus Emblica .	Zibyu . .	February.	

List of species found in the Natmauk township—concld.

Natural order.	Scientific name.	Burmese name.	Month in which flowers were collected.	REMARKS.
Euphorbiaceæ —*contd.*	Jatropha multifida . .	Thinbaw-kanako	March.	
	Croton oblongifolius .	Theyin . . Theyingado .	„ . „ .	
	Homonoia riparia . .	Yemahnaing .	„ .	
Ulmaceæ .	Holoptelea integrifolia .	Pyaukseik .	February.	
Moraceæ .	Ficus Rumphii . .	Nyaungbyu .	...	
	„ nervosa . .	Nyaungpeinnè .	...	
	„ glomerata . .	Thapan . .	March.	
	„ Cunia . .	Nyaungkyat .	...	
Palmæ . .	Phœnix acaulis . .	Thinbaung .	...	
Gramineæ .	Bambusa Tulda . .	Thaikwa . .	...	Rare.
	Dendrocalamus strictus .	Hmyinwa . .	...	

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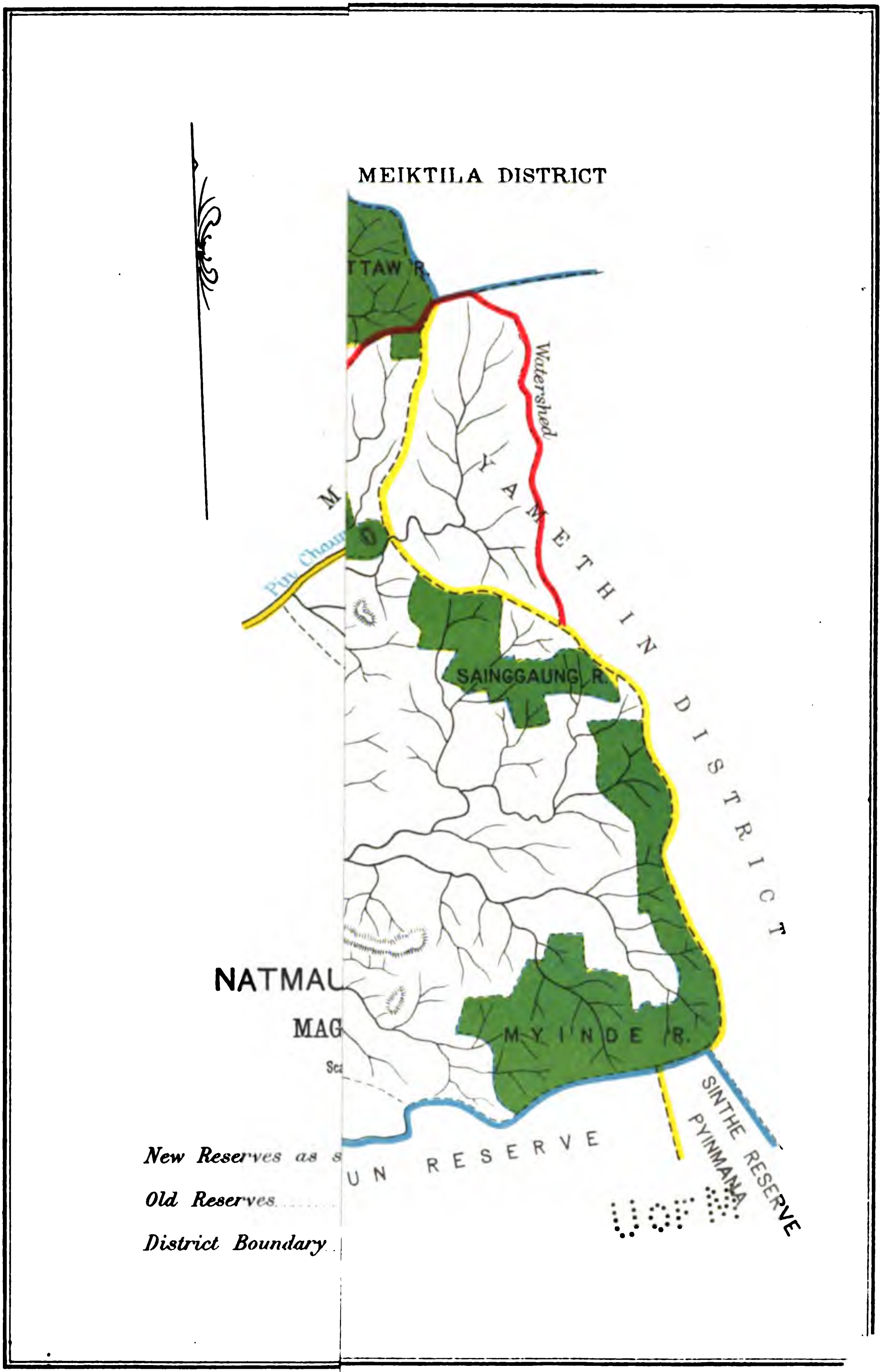

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District Boundary..

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Forest Pamphlet No. 7 [illegible] Forest Economy Series No. 2

ANDAMAN MARBLE-WOOD OR ZEBRA-WOOD

DIOSPYROS KURZII, Hiern

BY

R. S. TROUP, F.C.H.
Imperial Forest Economist to the Government of India

CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
1909

Price [illegible]

Forest Pamphlet No. 1, Chemistry Series No. 1—**On the Utilisation of Khair Forests in Eastern Bengal and Assam** *by Mr Puran Singh, F.C.S., Acting Imperial Forest Chemist* (1908).

Forest Pamphlet No. 2, Forest Zoology Series No. 1—**The Bark-Boring Beetle Attack in the Coniferous Forests in the Simla Catchment Areas** by E. P. Stebbing, F.L.S., F.Z.S., F.E.S., Imperial Forest Zoologist (1908).

Forest Pamphlet No. 3, Working Plan Series No. 1—**A Glossary of Technical Terms for use in Indian Forestry** *by A. M. F. Caccia, M.V.O., F.Z.S., I.F.S., Imperial Superintendent of Forest Working Plans.*

Forest Pamphlet No. 4, Forest Economy Series No. 1—**Lac or Lac Cultivation** *by D. N. Avasia, Extra-Assistant Conservator of Forests, Central Provinces.*

Forest Pamphlet No. 5, Silvicultural Series No. 1—**Notes on Sal in Bengal** by A. L. McIntire, I.F.S., Conservator of Forests, Bengal.

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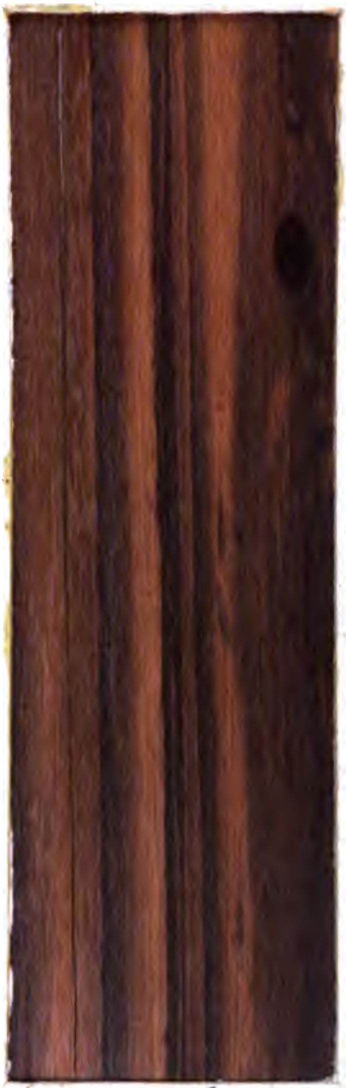

Diospyros Kurzii, Hiern.

Andamans Marble Wood or Zebra Wood—Andamans, Nicobars, Coco Islands.

ANDAMAN MARBLE-WOOD
OR ZEBRA-WOOD

DIOSPYROS KURZII, Hiern

BY

R. S. TROUP, F.C.H.
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SUPERINTENDENT GOVERNMENT PRINTING, INDIA
1909

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PREFACE.

THIS publication is the first of a series dealing with some of the more important Indian timbers, many of which are at present insufficiently known in commercial circles. Similar pamphlets on other timbers will be brought out from time to time, and will contain such information as is likely to be of use to wood merchants, engineers, architects and others interested in the utilization of Indian timbers.

R. S. TROUP.

DEHRA DUN,
28th January 1909.

NOTE ON

ANDAMAN MARBLE-WOOD OR ZEBRA-WOOD.

Diospyros Kurzii, Hiern.

Vernacular names. *Pecha-da,* And.; *Kala lakri* Hind. (in Andamans) ; *Thitkya,* Burm. (in Andamans).

Distribution.—Throughout the Andamans; also found in the Nicobars and Coco Islands, (rare, according to Prain, on Great Coco Island).

Type of forest.—The tree is found scattered in semi-deciduous and evergreen forests at elevations of about 50 to 300 feet, usually on low-lying and undulating ground. According to Mr. B. B. Osmaston, it is never gregarious or very numerous. Often 1 or 2 mature trees may be found to the acre, and sometimes more, in small patches. Mr. Osmaston also states that natural reproduction of the species is fair, and that artificial methods of reproduction have not been tried.

Description and size of tree.—An evergreen tree with smooth thin grey bark. Kurz states that it attains a height of 50 to 60 feet with a clear stem of 25 feet and a girth of 6 feet, but according to Mr. Osmaston, this is only exceptionally the case in the Andamans, the tree reaching a height of 40 to 50 feet with a clear bole of 15 to 20 feet and a girth up to 5 feet.

Size of timber obtainable.—Mr. Osmaston states that logs extracted average about 2¼ feet mid girth, but that as the heartwood is small, squares of over 6 inches siding are unobtainable. Mr. C. G. Rogers is of opinion that in forest which has not previously been worked squares up to

9 inches siding could be obtained. Some years ago Mr. Heinig reported that it squared up to 20 feet long with siding up to 9 inches, while Mr. Ferrars gave the length as 20 feet with siding up to 12 inches. From this it is evident that the larger sized timber has to some extent been cut out in accessible localities.

Mr. Osmaston further states that a log of 12 cubic feet would yield on an average only about 1 cubic foot of converted heartwood. Mr. Rogers believes that with regular working, resulting in the improvement of the forests, a larger proportion of good heartwood could be obtained, because many of the trees now available are overmature, and full of faults.

Description of wood.—Marble-wood, like the "Calamander-wood" of Ceylon (*Diospyros quæsita*, Thw.), is a variegated ebony, the chief value of which, for ornamental purposes, lies in the remarkable effect produced by alternating streaks of black and grey. Gamble's description may here be quoted:—"*Wood* hard: sapwood grey: heartwood streaked black and grey in more or less alternate layers, or rarely quite black. *Pores* small and very small, scanty. *Medullary rays* very fine, numerous, uniform and equidistant. Transverse bars very fine, numerous, irregular, faint."

I have had an opportunity of examining a number of specimens of the wood, with special regard to variations in marking. The grey markings are of various shades and sometimes have a pinkish tinge. The dark markings also vary in intensity, merging from jet black, sometimes with a deep purplish tint, into brown or greyish brown. The greater the contrast between the dark and light markings the handsomer is the specimen.

In many planks the dark and light markings are in the form of more or less regularly alternating longitudinal, often concentric bands, so that if a log be sawn in a longitudinal direction, particularly along a radius, a "zebra" type of marking is obtained (*vide* specimens 1 to 6 in the plate). The "marble" form of marking shown in specimens 11 and 12 of the plate are obtained by sawing at an angle to the vertical plane. "Marble" types of marking are also caused through the black markings occurring in large masses or irregular blotches (as in specimens 14 and 15), or by black knots in the wood (as in specimen 13). These black knots, unlike the knots in many woods, do not usually affect the homogeneity of the wood or interfere with sawing or planing. Specimens 7 to 10

1

2

3

4

5

6

7

8

9

10

11

12

13

14

15

Half-tone.

Survey of India Offices, C

SOME VARIATIONS IN TYPES OF ANDAMANS MARBLE WOOD.

show transition forms between the "zebra" and "marble" types of marking.

Mr. Herbert Stone's report.—In 1907 I sent a sample of marble-wood to Mr. Herbert Stone, of Birmingham, the well-known specialist on timbers. He has kindly examined the specimen, and reports as follows on it:—

"This wood is well known to turners and makers of 'Tunbridge-ware,' but it is surprising how rarely one sees it in use. I cannot recall having seen a piece of furniture in which Marble-wood was used. Nevertheless, it is highly spoken of by men in the trade, and I suspect that the irregularity of the supply, coupled with high price, may have something to do with its limited use. I do not doubt that all that can be sent over here will be readily purchased. The specimen is a very good sample and quite marketable. The greater the contrast between the alternate bands of Ebony and Whitewood, the more valuable it will be, and I suggest that logs in which the lighter bands are too brown should be carefully weeded out. We are now so much accustomed to seeing Ebony opening brown, that logs of Marble-wood in which the bands are not quite white will be taken for a very inferior Ebony, and the trade will be prejudiced. Ebony, now-a-days, is not so black as it is painted, or rather stained. I found the sample hard to saw, as might be expected, hard to plane, but coming up to almost a natural polish, and excellent to turn. It is a true turner's wood and is not nearly so brittle as Ebony. Polish makes the black parts blacker, which is good, but it also makes the brown bands browner, which is bad. It needs a little study and special treatment. The effect when polished is very fine. Laslett says that it is one of the handsomest timbers in the world, and I fully agree with him."

I might add, with reference to the working qualities of the wood, that a furniture-maker to whom I submitted samples in India found it by no means difficult to work, as compared with many other Indian woods.

Weight.—The weight per cubic foot has been ascertained from the following specimens, all of which were thoroughly seasoned:—

Serial No.	Museum specimen No. Forest College, Dehra Dun.	From whom received.	Weight in lbs. per cub. foot.	Remarks.
1	B 521	General Barwell.	62	These two specimens are mentioned in Gamble's "Manual of Indian Timbers," 1902, page 458. The weights have been checked and found to agree exactly with Gamble's figures.
2	B 2203	Colonel Ford, 1866	57	
3	B 2498	Home, 1874, No. 15.	66	The weight of this specimen is given by Gamble as 80 lbs. per cub. foot, but on checking I find it to be 66 lbs. Possibly the original weight may have been obtained when the specimen was green and therefore heavier.
4	B 5208	Deputy Conservator of Forests, Andamans.	54	No. 44 in Everett's Memorandum on Mechanical Tests of some Indian Timbers, Forest Bulletin No. 6, 1906.
5	B 5209	Ditto.	66	No. 45 in ditto.
6	B 5210	Ditto.	57	No. 46 in ditto.
7	B 5264	B. B. Osmaston, 1907.	56	Sapwood only.
8	B 5265	Ditto.	68	Heartwood only.
9	B 5266	Ditto.	67	Heartwood predominates.
10	...	Ditto.	59	Piece subsequently cut into small specimens.

The average weight works out at 61 lbs. per cubic foot (excluding Nos. 7 and 8 which consist only of sapwood and heartwood respectively). Nos. 1 to 6, 9 and 10 may be taken as normal specimens. Nos. 3 to 6 and 10 contain approximately equal amounts of heartwood and sapwood (*i.e.* dark and light streaks), Nos. 1 and 9 contain more heartwood than sapwood and No. 2 rather more sapwood than heartwood.

Strength.—In 1906 Professor Everett, of Sibpur Engineering College, published the following results of tests carried out on three specimens of marble-wood :—

No. in Everett's Memo on Mechanical Tests of some Indian Timbers.	Shearing strength along the grain (tons per square inch).	Crushing strength along the grain (tons per square inch).	Bending strength (tons per square inch).	Stiffness from bending tests, E. (tons per square inch).
44	1·000	3·78	4·34	724
45	0·990	4·24	5·19	795
46	0·848	3·98	5·34	900
Average . .	0·946	4·00	4·96	806

These figures are higher than those obtained at the same time for teak in all four classes of tests.

Seasoning qualities.—Messrs. Heinig and Ferrars say the wood is difficult to season and is liable to shrink and warp ; Mr. Osmaston adds that it is liable to split and warp if felled green. Undoubtedly it requires great care in seasoning, but the marble-wood planks which I have received from the Andamans have shown less tendency to warp and split than planks of several other Indian woods. I selected one of these marble-wood planks and carefully measured its volume by means of a Xylometer in November 1907 and again a year later; the shrinkage was only 0·2 per cent., which is practically negligible. The plank was a seasoned one, and the experiment would indicate that after seasoning there should be little fear of shrinkage with age.

So far the marble-wood logs in the Andamans have always been kept in the sea, and the wood has therefore never had a chance of being seasoned in any other way. It is possible that girdling some time before felling, or dry seasoning, may have a better effect on the timber than salt-water seasoning. In any case it would appear necessary to season thoroughly before converting into scantlings of small size.

Method of working and extraction.—The trees have hitherto been marked for felling under a rough selection system, the number felled per annum depending on the demand for the time-being. The work of felling and extraction is carried out departmentally by the Forest Department with convict labour. So far the wood has always been extracted in the round, the logs being dragged by elephants or buffaloes to the nearest creek and then floated down to the saw-mills by means of bamboos or lighter logs. There are no great difficulties attending extraction, but the greatest drawback lies in the fact that of 12 cubic feet extracted 11 are waste wood and only fit for fuel. Mr. Osmaston suggests dragging out the logs in short lengths of say 6 feet, by buffaloes, or trying hand sawing in the forest to reduce the bulk of the wood extracted.

Outturn.—Until the forests of the Andamans and neighbouring islands have been further explored it will be impossible even approximately to estimate the future outturn. Mr. Osmaston estimates that under present conditions of working some 500 cubic feet of heartwood per annum will be available for export. Hitherto about 100 logs per annum have been extracted, all of which have been used locally.

Demand.—So far the wood has not been regularly exported, but has been supplied locally to the Government Workshops at Port Blair. Samples have been sent to England and elsewhere from time to time in the past, but there has been no regular trade in the wood. Some sample planks were sent some years ago to Messrs. Hallé's pianoforte factory for piano cases, but no report regarding them was ever received.

Price.—The price at which the wood has been supplied to the Government Workshops at Port Blair is Rs. 90 per ton of 50 cubic feet, which is far too low, as it does not even pay the cost of extraction. Mr. Osmaston considers that it would probably cost the Forest Department Rs. 4 per cubic foot of heartwood f. o. b. Port Blair, and that in order to be remunerative the price should be fixed at about Rs. 6 per cubic foot of heartwood.

A small trial consignment of 8·5 cwt. sent home and sold by auction by Messrs. Churchill & Sim in London in 1878 fetched £ 2-15-0 per ton weight. Regular consignments at the present day would probably bring a much higher price.

Uses of the wood.—The wood is used entirely for ornamental purposes, for which it is one of the handsomest woods in the world. It is particularly suitable for cabinet-work, ornamental furniture, walking-sticks, fancy boxes, carving, turning, inlaid work, picture-frames and other similar articles.

Enquiries regarding the timber.—Enquiries regarding the timber should be addressed either to the Deputy Conservator of Forests, Port Blair, Andamans, or to the Imperial Forest Economist, Dehra Dun, United Provinces, India.

I am much indebted to Mr. B. B. Osmaston, formerly Deputy Conservator of Forests in charge of the Andamans, for a great deal of the information given above, while Mr. C. G. Rogers, also at one time in charge of the Andamans forests, has also kindly supplied me with many facts regarding the tree and its timber.

I am also much indebted to Mr. G. T. Wrafter, formerly Extra-Assistant Conservator of Forests in the Andamans, for a useful note on the subject of Andaman Marble-Wood.

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THE COLLECTION OF STATISTICAL DATA RELATING TO THE PRINCIPAL INDIAN SPECIES

BY

A. M. F. CACCIA,
Imperial Superintendent of Forest Working-Plans

CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
1909

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1909

PREFACE.

THE collection of statistics relating to the development of the principal Indian timber species froms for the next twenty years probably the most important duty of the officers connected with the working plans branch of the Imperial Forest Research Institute.

So far a certain number of figures have been collected by forest officers, but on such varying basis for different provinces and with so little regard for the uniformity, which is essential for collating the statistics, that the utilisation of the work done is not always possible.

Until a uniform procedure is introduced for the whole of India and experimental work is carried out and directed on identical lines, it will be impossible to compare and bring together data collected by various investigators working on the same species throughout the department.

With this object in view a series of experiments, and the rules governing the experiments, have been drawn up in the hope that, after their details have been discussed by Conservators, they will be recognised as the standard rules for collecting statistical data regarding the development of the principal timber trees in India, and the registers as prescribed will be employed for recording the results.

The work of collecting statistical data which may be under taken directly by officers of the Imperial Forest Research Institute during the next few years will necessarily be somewhat restricted. But it is evident that if the procedure to be followed in each case be carefully prescribed and adhered to, the investigations due to the officers of the Imperial Forest Research

Institute may be largely supplemented by those carried out by independent workers.

To arrive at the cubic contents of logs from girth and length measurements the use of Rai Kunhya Lall's tables has been prescribed, as given in his "*Useful rules and tables relating to measurement of timber,*" printed at the Thomason Civil Engineering College Press, Roorkee. These tables are based on the mean quarter girth squared.

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THE COLLECTION OF STATISTICAL DATA RELATING TO THE PRINCIPAL INDIAN SPECIES.

◆

INTRODUCTORY.

The various methods of procedure followed in collecting statistical data relating to the more important Indian species may be classified under two heads, namely :—

1. The measurement and observation of single standing trees and whole standing crops growing in experimental (or sample) plots.
2. The analysis and measurement of single felled trees.

The trees and crops taken under observation may again be divided according to their method of formation into :—

1. Seedling trees or crops, and
2. Coppice shoots or crops.

Accordingly the subject may be dealt with under the following heads :—

I.—THE ANALYSIS AND MEASUREMENT OF SINGLE FELLED SEEDLING TREES.

1.—The determination of the rate of girth increment by ring countings.
2.—The preparation of volume tables.
3.—The preparation of tables of form factors.

II.--EXPERIMENTAL (OR SAMPLE) PLOTS IN HIGH SEEDLING FORESTS.

1.—The determination of the rate of girth and height increment of selected type seedling trees, growing in an even-or uneven-aged, artificially thinned or unthinned crop.

2.—The determination of the rate of girth, height and volume increment of even-aged, pure or mixed, artificially thinned, or unthinned seedling crops : as well as the number of stems per unit of area at different ages.

3.—The determination of the percentages of stems in each girth class which pass into the next highest in an uneven-aged (Selection) high forest within the calculated average period.

4.—The determination of the rate of natural thinning in an even-aged crop, and the effect of thinnings of various intensity on the rate of girth, height and volume development of single trees and crops.

III.—EXPERIMENTAL PLOTS IN COPPICE WOODS.

1.—The determination of the rate of girth and height development of selected type coppice shoots, the clumps being artificially thinned or unthinned.

2.—The determination of the rate of girth, height and volume increment for different rotations of even-aged, pure or mixed coppice woods; the clumps being artificially thinned or unthinned.

CHAPTER I.

THE EXAMINATION AND MEASUREMENT OF SINGLE FELLED TREES AND THE STUMPS OF FELLED TREES.

SECTION 1.—RING COUNTINGS.

Object of experiment.

The object of ring countings is to determine the rate of mean annual girth increment in each girth class of single trees which have grown up under given conditions; that is the number of years taken to grow from one given girth class to one higher; and consequently the number of years (rotation) required to produce under given conditions trees of given girths. It is evident that such data can only be obtained from species showing distinct (true) annual rings.

Selection of stumps.

In the case of all forests under systematic working, ring countings should be confined to the year's felling area. Wherever fellings are being carried out in accordance with the provisions of sanctioned working-plans, the rings on the stumps of a certain number of the felled trees should be counted. The ring countings will therefore usually bear on trees of the higher girth classes; but ring countings should not be confined to these; stumps of trees of all girths, when available, will be taken into consideration. The upper section of the stump should show a clean cut, which may if necessary be made clear by the use of an adze.

Only the stumps of trees of normal growth should have their rings counted; and not those whose growth has been stunted by suppression, or for other reasons.

Similarly, ring countings will not be made on stumps with very excentric growth.

The aspect, the soil and the nature of growth surrounding each stump will be carefully recorded in the remarks column of the prescribed register.

Ring countings.

Ring countings will be made along a mean radius; the mean radius being calculated from the mean diameter, which will in its turn be the mean of the longest and shortest diameter.

The number of rings along each inch of the mean radius will be carefully counted from centre to periphery and recorded in the prescribed form, Form A.

The thickness of the Sapwood and Bark will also be recorded along the mean radius.

Register of ring countings.

A register of ring countings in prescribed Form A will be maintained. The data so collected will be collated and published from time to time.

Rules for the carrying out of ring countings.

Rule 1.—Only stumps of sound normally grown trees will be selected for ring countings.

Rule 2.—As a rule ring countings will be made of a certain number of stumps situated in the felling area of the year.

Rule 3.—The rings will be counted on a mean radius, inch by inch, from centre to periphery consecutively, as given in the sample form.

The mean radius will be obtained by taking the mean of the longest and shortest diameters without bark and dividing this by two, and laying this radius out on the stump. The wood along the mean radius will be smoothed with an adze or other instrument.

Rule 4.—The thickness of sapwood and bark along the mean radius will be recorded in inches and decimals of an inch.

Rule 5.—A steel tape will be used for recording these statistics.

Rule 6.—The nature of the soil, aspect, elevation, surrounding tree growth (*e.g.*, height corresponding to given girths, etc.), in the vicinity of the stump will be recorded in the remarks column of the prescribed register.

Rule 7.—A register in prescribed Form A will be maintained; and the data so collected will be collated and published from time to time.

PRESCRIBED FORM A.—REGISTER OF RING COUNTINGS AND

Working Circle and Felling Series.	Number of compartment.	Name of Forest.	Serial number.	AVERAGE NUMBER OF RINGS COUNTED FROM CENTRE																
				1"	2"	3"	4"	5"	6"	7	8"	9"	10"	11"	12"	13"	14"	15"	16"	17"
				CORRESPONDING TO TRUE CIRCLES																
				0' 6"	1' 1"	1' 7"	2' 1"	2' 7"	3' 2"	3' 8"	4' 2"	4' 9"	5' 3"	5' 9"	6' 3"	6' 10"	7' 4"	7' 10"	8' 5"	8' 11"
Sutlej Working Circle Chini Felling Series.	80	Boklie	1	11	20	30	43	52	67	82	90	118	138	159	175	189	214	257	..	...

MEASUREMENT OF SAPWOOD AND BARK ALONG MEAN RADIUS.

TO CIRCUMFERENCE OF MEAN RADIUS OF													MEAN THICKNESS IN INCHES OF		CALCULATED AGE OF TREES. GIRTH WITHOUT BARK.				Difference in age between trees of 4′6″ and 6′ in girth.	Difference in age between trees of 6′ and 7′6″ in girth.	REMARKS.
18″	19″	20″	21″	22″	23″	24″	25″	26″	27″	28″	29″	30″									
WITH CIRCUMFERENCE OF																					
9′ 5″	9′ 11″	10′ 6″	11′ 0″	11′ 6″	12′ 1″	12′ 7″	13′ 1″	13′ 7″	14′ 2″	14′ 8″	15′ 2″	15′8″	Sapwood.	Bark.	3′	4′ 6″	6′	7′ 6″			
...	...	...	...	...	...	...	...	...	...	...	...	...	2·0	1·2	61	109	167	...	58	...	...

SECTION 2.—THE PREPARATION OF VOLUME TABLES.

Object of experiment.

Volume tables show the average contents of standing trees of different sizes; they are used to estimate the yield of wood and timber for given localities; but they are intended only for estimating a large number of trees. The data so collected may also be used for calculating the age at which the mean annual volume increment of single trees culminates.

Volume tables may be prepared to show the total volume of trees of different sizes; or the volume of timber and smallwood separately for the whole tree or for the stem only; or the volume of merchantable timber; or the outturn which may be expected in logs or planks of a given size or other grades of timber. In each case it is essential that an exact definition of "*timber*," "*smallwood*," and "*graded timber*" be given.

As to the exact form of volume table which should be prescribed for India, opinions will vary considerably, since on the one hand, no scientific definition of "*timber*" as compared with "*smallwood*" has yet been accepted in India, and on the other hand no regular well established markets exist which would naturally prescribe the size of the different grades of timber.*

Collection of data.

For the present it is suggested that data be collected showing for each tree :—

(*a*) The girth at breast height (4′ 6″ from ground).
(*b*) The number of rings at base.
(*c*) The total height.
(*d*) The volume of stem timber (*i.e.*, timber over 24″ in girth).
(*e*) The length of merchantable bole in feet.
(*f*) The volume of merchantable bole in solid cubic feet.
(*g*) The outturn of merchantable timber in scantlings (*e.g.*, M. G. Sleepers, B. G. Sleepers, or other scantlings).

In addition, when possible, figures will also be collected showing separately—

(*h*) Total volume of timber (wood over 24 inches in girth).

---

* As a tentative measure it is proposed to prescribe for scientific investigations a girth of 24 inches as separating timber from smallwood.

(*i*) Total volume of smallwood (wood under 24 inches in girth).

(*j*) Total volume of tree timber *plus* smallwood.

By "*timber*" will be understood all wood over 24 inches in girth: whilst "*smallwood*" will include all material below this girth.

The definition of "merchantable bole," "log," and "scantling" will vary in different localities; but in each case a correct definition of each of these terms should be given in the register in which the data collected are recorded.

Measurement of trees.

The measurements will only bear on *sound* average trees; and as a rule the collection of statistical data herein prescribed will be restricted to trees felled in the coupe of the year.

(*i*) *Measurement of the cubic contents of stem timber.*—The volume of the stem up to a girth of 24 inches will be calculated by cutting up the bole into suitable lengths, the volume of each being taken as equal to—

$$\left(\frac{\text{Mid-girth}}{4}\right)^2 \times \text{Length};$$

Rai Kunhya Lall's tables being used for working out results.

(*ii*) *Measurement of the solid contents of smallwood.*—All wood below 24 inches in girth will be cut up into short lengths and carefully stacked; the stacked contents being converted into solid cubic feet by the use of co-efficients. Where no local co-efficients exist they should be ascertained from actual Xylometer measurements and recorded for future use.

(*iii*) *Measurement of merchantable bole.*—The definition of "merchantable" bole will vary in different localities. It is essential that a precise definition be entered in each case in the prescribed register, Form B.

The volume of utilizable bole will be calculated from the formula—

$$\left(\frac{\text{Mid-girth}}{4}\right)^2 \times \text{Length};$$

Rai Kunhya Lall's tables being used to work out results.

(*iv*) *Outturn in Scantlings.*—In localities where the timber is sawn up into sleepers or other scantlings, the exact outturn of such scantlings in numbers and in cubic contents should be recorded. The *exact* size and volume of the different grades of scantlings obtained should be fully recorded.

Rules for measuring trees for preparation of volume tables.

Rule 1.—Only trees of sound average growth will be selected for measurement.

Rule 2.—Trees for measurement will be selected from among those marked for fellings in the coupe of the year.

Rule 3.—The bole of the tree when felled will be divided into 2 portions at the point where it girths 24″ over bark, the portion above this girth being treated as "*timber*" and the rest as "*smallwood.*"

Rule 4.—The volume of the stem timber will be calculated by dividing the bole into sections of convenient length depending on size and taper of log, and calculating the volume of each section from Rai Kunhya Lall's tables by the formula : $(\frac{\text{Mid-girth}}{4})^2 \times$ length.

Rule 5.—The volume of the smallwood (if required) will be calculated by stacking and the "Xylometer" method, or by co-efficients, if available.

Rule 6.—When the bole timber is converted into scantlings the size and volume of scantlings should be recorded and the results entered in the prescribed register, Form B.

PRESCRIBED FORM B—MEASUREMENT OF TYPE TREES.

MEASUREMENT OF

Name of Range—Deoban

Name of Working Circle—Kangatha

Serial No.	Number of Compartment.	Girth at breast height (4′ 6″) in inches.	Total height of tree in feet.	Number of rings counted on mean radius.	Cubic contents of stem timber over 24″ girth.	CUBIC CONTENTS OF STEM OF TREE			MARKETABLE BOLE.		
						Timber over 24″ girth.	Small wood under 24″ girth.	Total Contents.	Length of Marketable Bole.	Mid girth of Marketable Bole.	Cubic contents of Marketable Bole.
					C.ft.				Feet.	Inches.	Cubic feet.
1	80	90″	77	157	148	...	...	...	70	72	157

TYPE TREES.

Species—Deodar.

Outturn in logs.		If sawn up, outturn in scantlings.								Remarks.
No.	Cubic feet.	Broad Gauge Sleepers.		Metre Gauge Sleepers.		Other Scantlings.		Total.		
		No.	Cubic feet.	No.	Cubic feet.	No.	Cubic feet.	No.	Cubic feet.	
...	...	18	63	...	...	4	8	22	71	Definition of Marketable Bole.

SECTION 3.—FORM FACTORS.

Object of experiment.

Form Factors are used to determine the actual volume of trees when girth and height are known. They may be prepared from girth measurements taken at any height from the ground ; and they may relate to the whole volume of the tree (timber only or timber and smallwood), or to the volume of stem timber, or to the volume of merchantable timber only.

For India, it will be advisable to prescribe the preparation of form factors based on measurements made at breast height, or 4′6″ from the ground (that is "*artificial*" form factors) ; and they should as a rule relate only to stem timber above 24″ in girth.

In addition merchantable timber form factors may also be prepared, based on the minimum size of timber which can be disposed of in the local market.

It must be remembered that form factors can only be applied in calculating the volume of a number of trees ; and that they must be founded on a very large number of measurements. The form of individual trees varies so much that a satisfactory average cannot be obtained unless a very large number of trees is measured.

Calculation of form factors.

Only sound trees will be selected for measurement, and the experiments will usually bear only on such trees as may be felled in the coupe of the year.

The stem timber form factor will be calculated from the formula—

Stem timber form factor $=\frac{\text{Actual volume of stem timber in solid cubic feet}}{\text{*Sectional area at breast height} \times \text{total height of tree}}$.

The actual volume of stem timber will be obtained by multiplying the $(\frac{\text{mid-girth}}{4})^2$ of each section by the length of each section of the stem, up to a minimum girth of 24 inches over bark.

The table of form factors to be prepared will show the form factors corresponding to given girths or heights.

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* The sectional area will be calculated from the formula : $(\frac{G}{4})^2$

Register of form factors.

The measurements taken will be recorded in the following prescribed register Form C :—

Serial No. of tree.	Total height of tree.	Girth of breast height.	Sectional area at breast height. $\left(\frac{G}{4}\right)^2$ at 4′ 6″	Volume of Cylinder= $\left(\frac{G}{4}\right)^2 \times H.$	Actual (measured) volume of stem timber above 24″ girth.	Stem Timber Form Factor.	REMARKS.
	Feet.	Inches.	Square inches.		Cubic feet.		

From the prescribed register, Form C, a Table of Stem form factors will be prepared in prescribed Form D by the graphic method, *viz.*—

Girth Breast-height in inches.	HEIGHT IN FEET.								
	40	50	60	70	80	90	100	110	120
	Average Stem Timber Form Factors.								
24									
30									
36									
42									
48									
54									
60									
66									
72									
78									
84									
90									

Rules for the Preparation of Form Factors.

Rule 1.—Only trees of sound average growth will be selected for measurement for the purpose of preparing form factors.

Rule 2.—The selected trees will be among those marked for felling in the year's coupe.

Rule 3.—Only the portion of the bole over 24″ girth (with bark) will as a rule be taken into consideration.

Rule 4.—The volume of the stem timber will be calculated by dividing the bole into sections and calculating the volume of each section by the formula : $(\frac{\text{Mid-girth}}{4})^2 \times$ length ; Rai Kunhya Lall's tables being used.

Rule 5.—The volume of the tree treated as a cylinder will be calculated from the formula $(\frac{G}{4}) \times H$; where $G =$ girth at breast height and H the length of the bole in feet up to the point where girth is 24″.

Rule 6.—The results of measurements will be recorded in the prescribed register, Form C.

Rule 7.—From the data recorded in register Form C, a Table of Stem Form Factors will be prepared by the graphic method and entered in prescribed Form D.

PRESCRIBED FORM C—REGISTER OF FORM FACTORS.

MEASUREMENT OF TYPE TREES.

*Name of Range*______________

*Name of Working-Circle*______________

Serial Number of tree.	Number of Compartment.	Total height (H) of tree in feet.	Girth (G) at breast height in inches.	Sectional area at breast height $\left(\frac{G}{4}\right)^2$ at 4½′.	Volume of Cylinder $\left(\frac{G}{4}\right)^2 \times H$ in cubic feet.	Actual measured volume of stem timber above 24″ girth in cubic feet.	Stem timber form factor.	REMARKS.

PRESCRIBED FORM D—TABLE OF STEM FORM FACTORS.

Girth breast height in inches.	Height in Feet.								
	40	50	60	70	80	90	100	110	120
	Average Stem Timber Form Factors.								
24									
30									
36									
42									
48									
54									
60									
66									
72									
78									
84									
90									

CHAPTER II.

RELATING TO EXPERIMENTAL PLOTS IN HIGH FORESTS.

SECTION 1.—THE COLLECTION OF DATA RELATING TO THE RATE OF GIRTH (OR DIAMETER) AND HEIGHT INCREMENT OF SELECTED TYPE SEEDLING TREES GROWING IN EVEN-OR UNEVEN-AGED, THINNED OR UNTHINNED, SEEDLING CROPS.*

Object of Experiment.

The object of such an experimental area is to determine the mean annual girth increment of the trees in each girth class growing under given conditions; that is, the period spent in each girth class; and hence the number of years (rotation) required to produce under those conditions trees of given girths.

Selection of plots and trees.

Selection of plots and trees.—In order that these objects may be achieved two conditions are necessary:—

(*i*) The individuals selected for measurements should be healthy, vigorous, and normally developed trees, which are likely to put on a normal (or average) increment during their passage through the girth class to which they belong.

(*ii*) Trees representative of all the girth classes, should be selected in order that the mean annual increment of each girth class may (if required) be separately determined.†

It is evident that dead and dying and wholly suppressed trees will not yield data which will assist in determining the mean annual increment of a class. For the same reason, trees situated along the edges of blanks, broad roads, fire lines or other clearings should not be selected. Again, though trees representative of all the girth classes should be selected, it is not necessary that the selection of these trees should be restricted to any given area. It is possible that the representative trees may be found all

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*A great deal that appears in this section has been taken from Mr. F. A. Leete's "*Notes on the collection of data as to the growth of trees and tree crops by means of sample plots in the United Provinces.*"

†Where (as is sometimes the case in a selection forest) the object is merely to determine the mean annual increment of the trees in the penultimate girth class, it will be sufficient to select representative trees of that girth class. Similarly, as regards seedlings of the smallest girth class, special plots would probably have to be established.

in one plot (as in the case of a selection forest); otherwise separate plots for the various girth classes may be established. The important point to be remembered is that the size of the plots will depend on the number of trees to be measured, not the reverse; and all girth classes need not necessarily be spread over an equal area.

Trees in different types of forest.—In addition it is evident that separate plots must be established for each type of forest, that is, wherever the quality of the locality varies so perceptibly as to exhibit marked differences in the development of the tree growth; *e. g.*, where the forest is situated on slopes presenting a wide range of elevation, or where the crops offer a great variety of aspects and soils.

Different species.—Each species to be brought under investigation must necessarily form the subject of a separate experiment, though no objection can exist to the trees of different species being included within the same experimental areas (*e.g.*, in a mixed forest), provided the several individuals are dealt with independently, each species being numbered and registered separately.

Preparation of sample plots.

The representative trees to be brought under observation having been duly selected, it will be found necessary to number these serially; to demarcate the boundaries of the sample plot; and to prepare a record fixing the position of the selected trees.

Numbering of trees.—Each species in a plot should have its own set of serial numbers. These numbers may either be painted on the bark of each tree with paint of good quality; or, the numbers may be stamped on tin plates, 4 inches square, which are then fixed *loosely* to the trees with wire nails, 4 inches long, driven in about 1½ inches.

Demarcating boundaries of sample plots.—The area within which the selected type trees are situated should be carefully demarcated on the ground by a ditch, 2′ by 2′, the salient corners being marked by good substantial posts, dressed and tarred. The form of the plots should be regular: in general the best shape is that of a long rectangle. A plan of the area on a fairly large scale (16″=1 mile) should be prepared; and a board should be set up on the edge of the plot indicating the number or name of the plot and the year in which the experiment was started.

Recording position of trees.—The position of each selected tree should, if possible, be recorded on a ground plan on a fairly large scale, the co-ordinates of each tree being also noted in the prescribed plot register—*vide* prescribed Form E. These co-ordinates will be two in number, namely the length of the offset on the base line, and the distance of the foot of the offset from the zero of the base line. In the case of plots which are more or less square, offsets could conveniently be taken from the diagonal.

Observation of Girth Increment.

Fixing point of measurement.—It is necessary that the periodical measurements be made at the same place on the stem. In order to ensure this a white ring will be painted round each tree, at the point at which the girth measurement is to be taken, the tape being always placed on the ring with the upper edges of the two coincident. The ring must be painted at right angles to the axis of the tree, with good English paint, which is likely to remain visible for a series of years, care being taken to force the brush right into the cracks in the bark. The trees selected will, if possible, be marked at breast height (4' 6" from the ground); provided the shape of the stem at this point is round and regular. On sloping ground this would be measured from the upper side of the tree. Otherwise the stem may be marked either above or below this point. Within certain limits there is no object in marking and measuring the trees at exactly the same height from the ground. The point is to measure the stem where it is regular. In order to obviate differences due to inaccuracies in the tape used for measuring, steel tapes should alone be used for the quinquennial measurements.

Time of taking measurements.—The measurements should always be taken in one and the same month. Theoretically the best time for the annual measurements would be the season when the tree is at rest, and its diameter or girth undergoes no change. This is not always possible in India, neither is it a necessity; the important point to be attended to being that a complete period of 12 months or multiple of 12 months should intervene between each consecutive measurement.

For various reasons, annual measurements will not be found of any practical utility; and quinquennial measurements are for all present record purposes sufficient. On the other hand, in order to ensure the proper maintenance of the sample plots, the renewal of the numbers and of the measuring marks, the plots should be carefully inspected annually. It will be necessary to prescribe therefore that the first measurements be always taken by a gazetted officer; and that subsequently the measurements be taken and recorded annually by Range Officials and quinquennially by a gazetted officer, the latter measurements alone being made use of for collation.

Classification of trees.—However carefully the trees may have originally been selected, it follows that in the course of time some of these will become suppressed, injured, etc. A careful observation of each tree will more correctly indicate how far the rate of girth increment may thereby have been affected. But in order that an indication of this may be given in the periodical records of the sample plot, it is advisable to classify the trees at each quinquennial measurement into the following classes, *viz.* —

1. Dominant = D.
2. Dominated = $\frac{d}{1}$, $\frac{d}{2}$, d, *viz.*—
   - $\frac{d}{1}$ = overtopped by a single tree on one side only.
   - $\frac{d}{2}$ = overtopped half-way round.
   - d = overtopped all round.
3. Dead.

As soon as a tree passes into the third class, further measurements will of course be discontinued.

Register of plots.—The measurements taken periodically in each sample plot must be recorded in a register to be maintained in the prescribed Form E. As already mentioned the first measurements will be taken by a gazetted officer, and thereafter measurements will be taken and recorded annually by a range official, and again quinquennially by a gazetted officer; the last measurements alone being entered in the Divisional prescribed register together with such observations and remarks as the Divisional officer responsible for the same may wish to make. Great care must be taken that the measurements are always taken in one and the same month; and in addition each tree will be classified as "Dominant," "Dominated," or "Dead" in the manner prescribed in a previous section.

All measurements will be recorded in inches and decimals of an inch. The recording of feet and inches separately, and the use of the "parts" of an inch must be avoided.

One register will be maintained for each sample plot, and as a rule for each species also; though the several species under observation in one and the same plot may be entered in the one register, provided they occupy different portions of the same.

It is very important that the prescribed register, Form E, should contain full particulars relating to the *situation, aspect, elevation, soil, rainfall, past history as regards fires, fellings, insect attacks*, etc., etc., of the sample plot selected ; and necessary provision for all such entries have been duly made.

Calculation of mean Annual Girth Increment.—The data relating to each 5-year period will be collated, the mean annual increment as calculated being entered in a register in prescribed form, Form F. The rate of mean annual girth increment will be calculated separately for each 18-inch girth class and again for all the girth classes combined up to 6′ and again 7′ 6″ ; and the results so obtained will be published in pamphlet form for each species separately at the end of each 5-year period. It would be advisable, therefore, if this is considered feasible, if all Conservators could agree to fix on one and the same year for the 5-year periodical measurements of all sample plots relating to the same species so that complete data could be published periodically.

Observation of Height Increment.

Whenever possible the height of the selected trees in each sample plot corresponding to given girths should also be recorded, as this gives perhaps the best indication of the quality of the locality.*

Time of taking measurements.—Height measurements will be taken by a gazetted officer at the same time as the periodical girth measurements are taken, that is quinquennially, or, where work is heavy, decennial measurements will be sufficient. In the latter case, the work could be so arranged that half the sample plots are measured alternately at the end of each 5-year period.

Instruments to be used.—When it is possible and necessary to take the height of standing type trees, the height instruments used should be of the same pattern : the name of the instrument being recorded in the register.

Register of Plots.—The measurements taken will be entered in the same register prescribed for girth measurements, *vide* Form E, in their proper column.

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* It will often be impossible to directly determine periodically the height of the selected type trees, whose girth increment is under observation. In such cases the heights of felled trees of various girths, grown in the same locality, can be utilised as described in Chapter II, Section 2, page 44.

Calculation of mean annual height increment.—The mean annual height increment will be calculated and recorded in the same manner as the mean annual girth increment, *vide* register Form F.

Thinnings.

The principles on which thinnings may be carried out for the benefit of the selected type trees of a crop will necessarily differ to a certain extent from similar operations undertaken in crowded even-aged woods with the object of obtaining the most favourable development of the whole crop. In the latter case, the thinnings would be undertaken for the benefit of the crop as a whole, whereas in the first case the thinnings would be solely for the benefit of the selected type trees. The removal of all trees, (generally of inferior species), overtopping the selected type trees under observation would naturally form the most important feature of any such thinnings; but in addition it may also be found necessary in certain special cases to still further increase the growing space allotted to each tree under observation. Bearing these remarks in mind artificial thinnings undertaken for the benefit of selected type trees may be divided into three classes, to be defined as follows :—

(*i*) *Light Thinnings*, which would include the removal only of any trees actually overtopping the selected type trees.

(*ii*) *Moderate Thinnings*, which would further include the removal only of such trees as are actually interfering with the lateral development of the crowns of the selected type trees. As a result of a moderate thinning the crowns of the selected type trees would just touch the crowns of the adjoining trees when shaken by the wind;

(*iii*) *Heavy Thinnings*, which would further include the removal of surrounding trees so that the crowns of the selected type trees remain detached and isolated.

On the other hand, in the case of the measurement of type trees growing in even-aged crops, the thinnings may be carried out in accordance with the principles enunciated in Chapter II, Section 2, page 46 : a heavy, moderate or light thinning being given the interpretation therein prescribed.

In carrying out so-called thinnings in uneven-aged crops the necessity of maintaining a suitable number of representative individuals of the various girth classes may frequently help in arriving at a decision as to which of the adjoining selected type trees should be removed.

In every case, the kind of thinning (if any) contemplated should be carefully noted.

Time of carrying out the thinnings.—The intervals of time at which the thinnings should be carried out, as well as their intensity (as above defined), must be carefully laid down. As a rule the thinnings will be carried out at the time of (and immediately before) taking the quinquennial measurements.

Register of sample plots.—In the register of sample plots (Register prescribed Form E) the fact as to whether the growing space allotted to each selected type tree is artificially regulated or not, and whether the thinning made is a heavy, moderate, or light one should be carefully entered.

Rules relating to Sample Plots established with the object of determining the rate of girth (or diameter) and height increment of selected type trees growing (a) in artificially unthinned crops, even-or uneven-aged; (b) in artificially thinned crops, even-or uneven-aged.

Selection and Preparation of Plots.

Rule 1.—A plot will be chosen for each type of forest, showing distinct variations in the quality of locality.

Rule 2.—The size of a plot will depend on the number of trees to be measured; not the reverse.

Rule 3.—Only selected trees will be measured, normally vigorous and healthy ones being chosen. As a rule, the following kinds of trees will not be selected:—

(*a*) isolated ones with large crowns;
(*b*) short and crooked ones;
(*c*) coppice shoots.

Rule 4.—As a rule, representatives of each of the 18-inch girth classes will be selected. The representative of the various girth classes may occupy one and the same or separate sample plots; and in the latter case the various sample plots need not occupy the same area.

Rule 5.—Each species will form the subject of a separate experiment, but the trees of the different species under observation may be situated within one and the same sample plot if suitable trees of more than one species are available in one place.

Rule 6.—The area of each sample plot will be demarcated by a narrow ditch (2′ × 2′), the salient corners being marked by pillars or by good substantial posts, dressed and tarred. As far as possible, the shape of each plot should be rectangular.

Rule 7.—Type trees will not be chosen within a distance of half a chain from the edge of a road, fire-line, or other clearing.

Rule 8.—The position of each tree will be recorded—

(*a*) on a map;
(*b*) in the prescribed register, Form E.

Rule 9.—The type trees will be serially numbered, each species in a separate series, either with numbers painted on the trunk of the tree, or with tin labels (4″ × 4″), loosely fixed by 4″ wire mails driven in about 1¼″; the numbers being stamped (not painted) on the tins.

Rule 10.—The point of girth measurement will be denoted by a band of white paint described round the bole of the tree : the following details being carefully observed :—

(*a*) the rings will be at right angles to the axis of the trees ;

(*b*) the rings will be more or less at breast height from the ground (*i.e.*, at a height of 4 feet 6 inches), but irregularities or excrescences must be scrupulously avoided ;

(*c*) a good brand of zinc oxide paint will be used to avoid frequent renewals.

Rule 11.—The rings and numbers will be renewed as often as required.

Rule 12.—The thinnings to be carried out, if any, and their intensity will be carefully laid down ; the operation being described as light, moderate, or heavy in accordance with the following definitions :—

(*a*) *A light thinning.*—Only trees overtopping selected type trees to be removed.

(*b*) *A moderate thinning.*—As for (*a*) and, further, trees actively interfering with the lateral development of the crowns of selected type trees.

(*c*) *A heavy thinning.*—As for (*a*) and (*b*) and the crowns of the selected type trees to be isolated and to remain detached.

Thinnings, if any are prescribed, will be carried out in the first year when the sample plot is laid out ; and be repeated, if necessary, every 5 years, at the time of taking measurements.

Measurements.

Rule 13.—Girths, and heights (if taken), will be measured in the first and every 5th year by a gazetted officer ; and in addition the sample plots will be measured and reported on annually to the Divisional officer by a Range official.

Rule 14.—Provided no change is subsequently made, the month of measurement is immaterial ; but one or more complete years' growth must intervene between the successive measurements.

Rule 15.—All girth measurements will be made with the upper edge of the tape touching the upper edges of the rings of paint.

Rule 16.—Steel tapes will alone be used for the quinquennial measurements and, if possible, for all others.

Rule 17.—Measurements will be taken in *inches* and decimals of an inch. " Parts " of an inch will not be used.

Rule 18.—The trees will be classified as follows :—

(*a*) Dominant (=D in register).

(*b*) Dominated (=$\frac{d}{1}$, $\frac{d}{2}$, or d in register) :—

$\frac{d}{1}$=overtopped by a single tree on one side only.

$\frac{d}{2}$=overtopped up to half way round.

d=overtopped over half way round.

(*c*) Dead.

Upkeep of Registers.

Rule 19.—The register of sample plots will be kept up in the prescribed Form E.

Rule 20.—The periodical mean annual increment for each 5-year period will be calculated, and the results will be entered in the prescribed register, Form F ; and published from time to time

PRESCRIBED FORM E—REGISTER OF SAMPLE PLOTS TO DETERMINE THE GIRTH AND HEIGHT DEVELOPMENT OF SINGLE TREES.

REGISTER OF SAMPLE PLOTS.

*Name of Reserve, Range or Working Circle*____________________

*Civil District, Forest Circle and Province*____________________

*Name of Sample Plot*____________________

Species.	Area or number of trees.	Facts to be ascertained.	Date of first measurements.	Intervals at which measurements taken.	REMARKS.

Descriptive details :—(Latitude, Longitude, Rainfall, Elevation above M. S. L., Soil, etc.)

Girth class.	Tree number.	Position.		On th of 19 .				On th of	
		Base.	Offset.	Classification.	Girth in inches.	Height. Feet, inches.	Remarks.	Classification.	Girth in inches.

19 .		On th of 19 .				On th of 19 .			
Height. Feet, inches.	REMARKS.	Classification.	Girth in inches.	Height. Feet, inches.	REMARKS.	Classification.	Girth in inches.	Height. Feet, inches.	REMARKS.

PRESCRIBED FORM F—CALCULATION OF PERIODICAL MEAN ANNUAL GIRTH INCREMENT AND OF MEAN HEIGHT OF SINGLE TREES.

INDEX.

Province.	Forest Division.	Name of Sample Plot.	Species.	Page.

*Name of Sample Plot*____________________________

*Name of Forest Division*__________________________

*Name of Province*______________________________

Girth class.	Species.	Period 19 to 19 .			Period 19 to 19 .			Period 19 to 19 .			Period 19 to 19 .		
		Number of trees.	Mean Annual Girth Increment.	Mean Height.	Number of trees.	Mean Annual Girth Increment.	Mean Height.	Numbe of trees.	Mean Annual Girth Increment.	Mean Height.	Number of trees.	Mean Annual Girth Increment.	Mean Height.

SECTION 2.—THE COLLECTION OF DATA RELATING TO THE RATE OF GIRTH (OR DIAMETER), HEIGHT, AND VOLUME INCREMENT OF EVEN-AGED, PURE OR MIXED, ARTIFICIALLY THINNED OR UNTHINNED SEEDLING CROPS; AND THE NUMBER OF STEMS PER UNIT OF AREA AT DIFFERENT AGES.

Object of experimental plots.

The development of a whole crop will usually be studied with the ultimate purpose of collecting data which will eventually lead to the preparation of *Yield Tables.* Yield tables are required to show per unit of area the number of stems, the mean height and girth (or diameter), the basal area, and the volume of normal woods of different ages according to quality classes. It will be necessary therefore to collect statistical data relating to each of these factors. In addition, the wood under observation may be subjected to thinnings; and in that case the intensity of the thinnings should be clearly defined, so that the effect of such operations on the development of the crop may be fully realised.

Under present conditions of forestry in India, it will seldom be found possible to lay out and maintain experimental plots of this nature, except perhaps in the case of certain coniferous woods in the Himalayas, naturally produced, and in the case of certain teak, babul, eucalyptus and casuarina artificial plantations. In every case, but more especially so when the sole object of such experimental plots is to prepare yield tables expeditiously, a number of plots of different ages should, if possible, be selected, such plots varying in age by periods of 10 to 20 years.

Selection of Experimental Plots.

In the selection of experimental plots suitable for studying the development of whole even-aged crops two conditions are necessary:—

Firstly, the sample plot must be of sufficient size; and
Secondly, the plot must be fully stocked with an even-aged crop of healthy, vigorous, and normally-developed individuals.

The difficulty which may be experienced in selecting even-aged woods of any appreciable extent is fully recognized; but on the other hand no sample plot of less than *half an acre* in extent should be taken under observation; and not only should the area of the sample plot itself be fully and evenly stocked, but an adjoining strip of forest of similar composition should also be available.

Experimental plots may be required for each different type of forest; and either a separate plot for each different species, or the development of a mixed crop may be studied, when the species growing together are both equally saleable, such as Sissoo and Mulberry, Deodar, and Kail, etc., etc.

Demarcation of Experimental Plot.

The experimental plot selected will be of a regular shape, preferably in the form of a rectangle; and the boundaries of the plot will be demarcated by a ditch, 2′×2′, with pillars of good substantial posts, dressed and tarred, at the corners. A board should also be erected at the edge of the plot indicating its name or number, and the year in which the experiment was started.

The outer boundaries of the sample plot should not be situated within half a chain of a blank, road, fire-line, or other clearing.

A map of the experimental area on a fairly large scale will be prepared: and the position of the sample plot will also be indicated on the available forest maps of the locality.

The exact area of the experimental plot will be carefully taken out from the plan by means of a planimeter.

The dimensions on the plan will be the actual measurements taken along the slope, the average angle of the slope of the plot, in degrees, being determined and recorded.

Determining age of the Plot.

Except in the case of plantations, whose age is definitely known, the mean age of the crop in the sample plot will be determined by ring countings on stumps of trees felled in the adjoining area of forest, the mean thus calculated being verified by countings on stumps of trees removed from time to time in thinnings, etc., in the plot itself.

Measuring the development of the crop.

Cleanings and Thinnings.

(*i*) *Girth Measurements.*—After the area of the sample plot has been demarcated, all dead and dying trees situated within the boundaries of the experimental plot will be removed; and in addition a thinning may be carried out, if prescribed.

Again, at the time of each quinquennial measurement (to be prescribed lower down) a similar cleaning and thinning would be carried out, the volume of the material so removed being carefully measured and recorded.

Fixing point of measurement.

In order that periodical girth measurements of the trees, forming part of the crop to be brought under observation, be made at the same place on the stem, it is necessary to paint a ring of white paint round the stem of each tree at the point at which the measurements are to be taken. This will be done in exactly the same manner as has been indicated in the case of the girth measurement of selected type trees : *vide* page 21, *ante.*

The trees should also be numbered, as indicated on page 20.

Time of taking measurements.

The plots should be measured up regularly at the end of very five-year period, and in the same month ; but provided no change is subsequently made it is immaterial what month is taken for the periodical measurements, provided it falls within the working season.

Method of taking girth measurements.

After the removal of the dead trees, and the carrying out of such thinnings as may have been prescribed (*vide* page 38) at the time of the periodical quinquennial measurements, the girth of all the stems forming the crop will be carefully measured separately, the exact girth of each stem being recorded in inches and decimals of an inch, and then abstracted into 6″ girth classes ; and therefrom the *mean* girth will be calculated, the latter alone being entered in the prescribed register, Form G ; the detailed measurements being maintained in the Range or Divisional office.

All girth measurements will be taken with a steel tape ; the upper edge of the tape touching the upper edges of the ring as previously laid down in the case of measurement of type-trees.

From the mean girth and from the total number of the stems standing on the area, the total basal area of the stems constituting the crop will be determined from the formula :—

$$\left(\frac{\text{mean girth}}{4}\right)^2 \times \text{number of stems.}$$

(*ii*) *Height measurements.*—The mean height of the trees remaining in the crop after the quinquennial cleanings and thinnings have been made will be calculated from actual measurements of trees removed in such cleanings and thinnings, suppressed trees being ignored, and also from sample trees cut in adjoining areas; the result being entered in the prescribed register, Form G.

(*iii*) *Number of stems and basal area.*—The girth measurements will give the total number of stems on the plot of known area, as well as the "basal area" of the crop. The number of stems so determined and the total basal area of the stems will be entered in the column reserved for the purpose in the prescribed register, Form G.

(*iv*) *Volume of growing stock.*—The volume of the growing stock will be divided into two parts:—

(*a*) Timber,
(*b*) Smallwood.

For the purpose of these experiments, timber will be defined as all parts of the stem and branches over 24 inches in girth; everything below this girth being classed as smallwood.

In order to determine the volume of the growing stock at the time of the quinquennial measurements, one or more sample trees must be selected in a strip of forest adjoining the actual experimental area set aside for this purpose; the size of the sample tree being determined by the method of the arithmetical mean sample tree.* In addition the volume of the intermediate fellings must be carefully recorded (*vide* section relating to thinnings on page 38).

In calculating the volume of the timber of all felled trees, the volume of each section of the tree will be calculated from the midgirth and length by using Rai Kunhya Lall's tables.

For the smallwood, the timber is to be stacked and measured and the results reduced to solid cubic feet by applying suitable co-efficients; the correct co-efficient for reducing being calculated from actual xylometer measurements.

The volume of the trees removed in thinnings at the time of the quinquennial measurements, and the volume of the growing stock, both "timber" and "smallwood" will be entered in their appropriate columns in the prescribed register, Form G.

(*v*) *Calculation of the mean annual increment.*—By dividing the total volume of the wood at any age *plus* intermediate yields (*i.e.*, thinnings) by the age of the crop, the mean annual increment is obtained. This will be calculated separately for timber only, and for timber and smallwood combined.

**Vide* Schlich's Manual of Forestry, Volume III, page 49.

(*vi*) *Form Factors.*—The form factor for timber (*i.e.*, wood over 24 inches in girth at the smallest end) and for timber and smallwood (*i.e.*, for whole volume of wood) will be calculated from the formula—

$$\text{Form factor} = \frac{\text{Actual Volume of timber or Timber and smallwood}}{(\text{Sectional area of all trees}) \times (\text{mean height of wood}).}$$

The form factors so calculated will be entered in their proper place in prescribed Form G.

Register of Plots.

The measurements taken periodically in each sample plot, whether these relate to the number of stems in the plot, the mean girth or height, or the mean volume of the crop and its mean annual increment, will be entered in prescribed register, Form G. A register in this form will be maintained both in the Divisional office, and in it copies of the quinquennial measurements will be entered together with such observations and remarks as the Divisional officer responsible for the same may wish to make : special reference being made to the factor employed in reducing stacked cubic feet of smallwood to solid cubic feet.

The measurements so recorded will show the development of the crop on the demarcated area of the sample plot selected, whatever this area may be. Subsequently such data must be made applicable to an area of one acre ; and the figures so deduced will be published from time to time in pamphlet form.

Thinnings.

Whenever the crop, within which the selected trees to be brought under observation are situated, is artificially thinned, some indication will be given regarding the principles on which these fellings are to be conducted, that is, whether a *light*, *moderate*, or *heavy* thinning is to be carried out.

The difficulties which must necessarily be experienced in attempting to give an exact definition of any one of these three classes of operations will be readily realised ; so much must depend on the nature of the crop, on the factors of the locality, and on the personal element. Nevertheless it is advisable to define the nature of the operation to be carried out as nearly as possible, and for this purpose the following classification given by Mr. Fernandez on pages 472-473 of his Manual of Indian Sylviculture will be prescribed :—

> The individuals composing any crop may, according to the vigour and fulness of their crown, be grouped into the following five easily distinguishable classes :—
>
> I. *Overtopping trees*, possessing exceptionally well-developed crowns and standing well above all the rest.
>
> II. *Dominant trees*, possessing well-developed crown. As a rule, these mainly form the leaf-canopy.
>
> III. *Dominated trees, i.e.*, those about to be overtopped. These are generally trees that have recently been in Class II, but, owing to weaker growth, have been left behind in the race. Their crowns will be already found to be more or less contracted and in some of them incipient decline will be noticed.
>
> IV. *Overtopped trees.*—Crowns very appreciably contracted either on every side, or on one side only. In some species the boughs and other large branches will be found bearing an abnormal number of short twigs grouped together in thick bunches. These trees may either (*a*) have the clear sky above them, but be closely hemmed in laterally, or (*b*) have only a part of their crown free, the rest being completely overshadowed. Not unfrequently many dead branches will be noticeable.
>
> V. *Suppressed trees.*—Such individuals, if belonging to conspicuously shade-enduring species, may still have perfectly green crowns ; otherwise the crowns will be found to be quite dead or in a dying condition.
>
> It is an essential rule in making thinnings that the soil shall not be uncovered to such an extent as to expose it to deterioration and that the individual trees shall not be isolated to such an extent as to render them liable to get bent or broken. Hence the severity of a thinning will be different according to the different prevailing conditions of growth in each case. For all practical purposes, however, it is sufficient to distinguish three degrees of severity as follows :—
>
> 1. *Light thinnings*, in which only suppressed trees are taken out. Such thinnings hardly help nature at all, but serve mainly to utilise stems that have practically ceased to exercise any impending action on the growth of the rest of the crop.
>
> 2. *Moderate thinnings*, in which, besides suppressed individuals, those of category (iv-*b*) of overtopped trees and a great many of category (iv-*a*) are also removed. This will without doubt be the class of thinnings most widely used in India.
>
> 3. *Heavy thinnings*, in which all suppressed and overtopped trees must disappear, and also perhaps a few of those that are about to be overtopped.

Volume of material removed in thinnings.—The volume of the material removed in thinnings at the end of each 5-year period should be calculated by actual measurement, the wood obtained being classified as timber and smallwood. The volume of the latter, which would include all wood below 24 inches in girth, would be determined by stacking the wood and using co-efficients in order to convert the stacked volume into solid cubic feet ; whereas the volume of the timber will be determined by the use of Rai Kunhya Lall's tables.

The volume of thinnings obtained for each periodical operation will be entered in its proper columns in the prescribed register, Form G.

Rules relating to Sample Plots established with the object of determining the rate of girth, height and volume increment of veen-aged, pure or mixed, artificially thinned or unthinned seedling woods; and the number of stems per unit of area at different ages.

Selection and Preparation of Plots.

Rule 1.—A plot will be chosen for each type of forest: the latitude, elevation above M. S. L., aspect, slope, soil, rainfall, etc., being carefully noted.

Rule 2.—Each plot will be of a suitable size: not less than half an acre in extent.

Rule 3.—Each plot will be fully stocked with an even-aged crop of healthy, normally-developed trees.

Rule 4.—Each species will form the subject of a separate experiment unless the object is to determine the development of an even-aged *mixed* crop.

Rule 5.—The area of each sample plot will be demarcated by a narrow ditch (2′×2′), pillars or substantial posts, dressed and tarred, being erected at the corners. The shape of each sample plot should be rectangular. A board will also be erected indicating the name or number of sample plot.

Rule 6.—Sample Plots should not be selected within a distance of half a chain from the edge of a blank, road, or other clearing. A strip of wood similarly stocked and similarly treated will be left adjoining the sample plot area, in order to supply the sample trees required for the calculation of the volume of crop.

Rule 7.—A plan of the sample plot on a large scale will be prepared; and the position of the experimental area will be indicated on the ordinary forest maps.

Rule 8.—Each tree in the experimental area should have a band of white paint described round the bole at the point of girth measurement: the following details being observed :—

(*a*) the rings are to be at right angles to the axis of the tree;

(*b*) the rings are to be more or less at breast height from the ground, but irregularities and excrescences must be scrupulously avoided;

(c) a good brand of zinc oxide paint should be used to avoid frequent renewals.

(d) the rings must be renewed as often as required.

Rule 9.—The artificial thinnings to be carried out (if any), and their intensity will be carefully prescribed; the operation being described as light, moderate, or heavy in accordance with the following definitions:—

(a) *light thinning*—only dead and suppressed trees will be removed;

(b) *moderate thinning*—suppressed trees and a proportion of overtopped trees will be removed;

(c) *heavy thinning*—all suppressed and overtopped trees will be removed; and also perhaps a few of those that are about to be overtopped.

Rule 10.—Thinnings will be carried out in the first year and every fifth year at the time of (*e.g.*, immediately preceding) the periodical measurements. Thinnings will be carried out by a gazetted officer. Where no special thinnings are prescribed, a cleaning to remove dead trees will be carried out, the volume of such trees being taken into account in all but the first year's measurements.

Rule 11.—The mean age of the crop will be ascertained by ring countings on stumps of trees felled in areas adjacent to the sample plot, such determination being verified by actual ring countings on stumps of trees removed from the plot from time to time in thinnings, etc.

Measurements.

Rule 12.—All measurements (girths, height, volume, etc.,) will be taken in the first year and every fifth year by a gazetted officer; and the results of such measurements will be forwarded to the Imperial Forest Research Institute.

Rule 13.—So long as no change is subsequently made, the month of measurement is immaterial, provided it falls within the working season.

Rule 14.—All girth measurements will be made with the upper edge of the tape touching the upper edges of the rings; a steel tape being used.

Rule 15.—The trees constituting the crop will be enumerated in 6-inch girth classes; and therefrom the mean girth of the crop will be calculated.

Rule 16.—The height of each tree will be taken by actual measurements of felled trees and samples trees felled in the adjoining areas for this purpose; and the mean height carefully calculated from such measurements.

Rule 17.—In calculating the volume of the growing stock, the mean arithmetical sample tree will be determined, and its volume obtained by felling one or more trees in the strip of forest set aside for the purpose, immediately adjoining the actual experimental area.

Rule 18.—The volume of timber (wood above a minimum girth of 24 inches), and of the smallwood (wood below that girth), will be calculated separately. In calculating the volume of each sample tree, the cubic contents of each piece of timber will be obtained from Rai Kunhya Lall's tables.* The volume of firewood will be calculated in stacked cubic feet; the whole being converted into solid cubic feet by the use of coefficients.

Rule 19.—The volume of material removed in thinnings will be calculated by actually measuring the felled material in the manner prescribed for the sample trees in the preceding rule (Rule 18).

Recording Observations.

Rule 20.—All measurements taken will be recorded in a prescribed register in Form G., and published from time to time, after reducing all measurements to the acre.

---

* In the manner detailed in rule 4, page 11, *ante*.

PRESCRIBED FORM G—REGISTER OF SAMPLE PLOTS TO DETERMINE THE DEVELOPMENT OF A WHOLE EVEN-AGED CROP.

*Name of Reserve, Range or Working Circle*____________________

*Civil District, Forest Circle, and Province*____________________

*Name of Sample Plot*____________________

Species.	Area of Plot.	Facts to be ascertained.	Date of first measurements.	Intervals at which measurements taken.	REMARKS.

Descriptive Details and Journal :—

Record of

Year of measurement.	Age of crop.	Area.	Number of stems.	Girth of mean tree at 4½' from ground in inches.	Sectional area of all trees at breast height in square feet $\left(\frac{\text{Mean girth}}{4}\right)^2$ × No. of trees.	Mean height of crop in feet.	VOLUME OF WOOD IN SOLID CUBIC FEET.		
							Timber over 24" in girth.	Smallwood 24" in girth.	Total Timber and Smallwood.

Measurements.

Form Factor $= \frac{\text{Volume of wood}}{\text{Sectional area} \times \text{Mean height.}}$		Mean Annual Increment $= \frac{\text{Volume}}{\text{Age in years.}}$		INTERMEDIATE RETURNS (THINNINGS) IN SOLID CUBIC FEET.			
				Periodic Yields.		Summary of Yields.	
Timber over 24" girth.	Timber and smallwood.	Timber over 24".	Timber and smallwood.	Timber over 24" girth.	Timber and smallwood.	Timber over 24" girth.	Timber and smallwood.

SECTION 3.—THE DETERMINATION OF THE PERCENTAGE OF STEMS IN EACH GIRTH CLASS WHICH WILL PASS INTO THE NEXT HIGHER IN AN UNEVEN-AGED (SELECTION) FOREST WITHIN THE AVERAGE PERIOD AS CALCULATED FROM RING COUNTINGS OR AS ESTIMATED.

Object of experiment.

In a selection worked forest in order that the possibility may be calculated under certain of the various prescribed methods, it is necessary to ascertain the percentage of stems that are likely to pass from one girth class to the next highest within the age periods represented by the different girth classes. With 18-inch girth classes the percentages usually adopted in India are the following :—

Girth Class.	SPECIES.
	Teak in Burma.
II, 4½ to 6 feet	85 per cent.
III, 3 to 4½ feet	82 ,, ,,
IV, 1½ to 3 feet	57 ,, ,,

These figures are not based on actual experiments. The main object then of these experiments is to collect data which will help towards a solution of this question.

As a rule experimental plots of this nature will only be established in forests for which mean annual girth increment figures already exist, or in which experimental plots to determine the rate of girth increment have been laid down.

Selection of Experimental Plots.

The data required will be obtained by the periodical re-enumeration of selected areas. Such areas must be of sufficient size, either the whole of a compartment or a portion of a compartment, provided the areas selected contain two thousand trees as a minimum. The plots should also be fairly normally stocked : but no special care is required in their selection as in each case the whole of a compartment or coupe, or a portion of the same with natural boundaries, will be selected.

If possible one plot should be selected in each coupe, or in each alternate coupe. The larger the number of plots, the more complete will be the data collected.

Demarcation of Experimental Plot.

The sample plot should either include the whole of the area of a coupe or compartment, or a portion of the same, if possible, with natural boundaries. But where artificial boundaries are necessary, a ditch 2′×2′ will be the most effective way of demarcating off the plot. It will be sufficient as a rule to show the position and boundaries of the sample plot on the 4-inch (or larger scale) map of the forest; these limits being carefully recorded.

Measurement of the crop.

Each sample plot will be enumerated immediately after the fellings are completed in 18″ girth classes, namely—

Below	18	inches in girth.		
From and including	18	inches and up to	but not including	24″
Ditto	24	ditto	ditto	36″
Ditto	36	ditto	ditto	48″
Ditto	48	ditto	ditto	60″
Ditto	60	ditto	ditto	72″

A careful record of the number of trees in each girth class will be kept. The enumeration will be carried out with callipers, graduated to show 18-inch girth classes (*i.e.*, each graduation being made equal to 5·73 inches).

The following rules will be strictly adhered to:—

(*a*) Each tree must be measured at breast height (4′ 6″ from the ground), that is at the same height from the ground.

(*b*) The calliper must be placed at right angles to the axis of the tree, and the rule must touch the tree.

(*c*) The reading must be taken whilst the calliper rests on the tree, and not after it has been withdrawn.

(*d*) Creepers, etc., found on the trees must be removed before measurement; and in the case of an abnormal swelling or indenture, the measurement must be taken above and below it and the average taken.

(*e*) In the case of a tree which is divided into two or more limbs below the fixed height of measurement, each limb must be measured and recorded as a separate tree.

(*f*) On sloping ground the enumerator should stand on the upper side; and on flat ground the measurer will always face north.

The number of seedlings in the lowest girth class may either be counted (which is preferable), or they may be merely referred to as "numerous," "wanting," etc.

At the end of the felling-cycle or any other convenient period, the sample plots will be re-enumerated in exactly the same manner. In addition, a careful record will be kept of all trees removed and all casualties (*e.g.*, dead trees, windfalls, etc.) during the period elapsing between the successive enumeration surveys.

Sound and unsound trees.—The trees will be enumerated in two categories, *viz.*, sound and unsound. Trees of all classes must be considered unsound if they have any serious defects, such as a knotty trunk with many branches low down, cracks running up the stem, a rotten base or broken top. The supervising officer will check this classification into sound and unsound trees.

Register of plots.

The results of the various enumerations made in each of the sample plots will be recorded in a prescribed register in Form H.

Calculation of growth percentages.

Knowing the average rate of growth in the different classes, it will then be possible to work out the growth percentages as follows:—*

Number of trees passed into any class is equal to—
Number of trees passed out of the class, *plus*
Number of trees in the class at 2nd survey, *minus*
Number of trees in the class at 1st survey.

Using the following symbols:—

Class.	ENUMERATION.		Intervals between surveys. Years.	Class age periods. Years.
	1st.	2nd.		
Above I	a	A	n	--
I	a	A_1		t_1
II	a	A_2		t_2
III	a	A_3		t_3

---

* From "Notes on the collection of the data as to the growth of trees and tree crops by means of Sample Plots," by F. A. Leete, F.C.H., I.F.S.

Number of trees passing out of Class I into Class above "I" in n years . . . . . = $A - a$

∴ Percentage t_1 years . . . . . = $\frac{100\,t_1}{a_1 n} \times (A - a)$.

Number of trees passing from Class II to Class I in n years . . . . = $(A - a) + (A_1 - a_1)$.

∴ Percentage t_2 years . . . . = $\frac{100\,t_2}{a_2 n} \times (A + A_1) - (a + a_1)$

Number of trees passing from Class III to Class II in n years . . . . = $(A - a) + (A_1 - a_1) + (A_2 - a_2)$

∴ Percentage t_3 years . . . . . = $\frac{100\,t_3}{a_3 n} \times (A + A_1 + A_2) - (a + a_1 + a_2)$.

The calculations of percentages will be worked out as above and also by the graphic method and published from time to time, whenever sufficient data are available.

Rules relating to Sample Plots established with the object of determining growth percentages in crops in selection forest.

Selection and Preparation of Sample Plots.

Rule 1.—The boundaries of the sample plot should coincide with the boundaries of a coupe or compartment, or with part of a coupe or compartment, if possible, having natural boundaries, or be demarcated by a ditch 2′ × 2′.

Rule 2.—The sample plot should be of sufficient size to include at least 2,000 trees to be observed.

Rule 3.—The boundaries of the experimental area will be clearly shown on the existing forest maps. If any blanks occur within the area of the sample plot, their position and size will be indicated : a statement being prepared to accompany the plan of plot, showing—

(*a*) Wooded area ; (*b*) Blanks ; (*c*) Total area (*a* + *b*).

(*Computed*) *Measurements.*

Rule 4.—The trees standing on the area will be enumerated in 18-inch girth classes, namely—

Below	18 inches in girth.				
From and including	18 inches in girth and up to but not including			36″	in girth.
Ditto	36	ditto	ditto	54″	,,
Ditto	54	ditto	ditto	72″	,,
Ditto	72	ditto	ditto	90″	,,
Ditto	90 inches and over 90 inches in girth.				

Rule 5.—The girth measurement of trees will be taken with callipers graduated to show divisions equal to 5·73 inches (*i.e.*, 18 inches in girth).

Rule 6.—Trees of different species to be measured, will be entered in separate columns.

Register of the Sample Plots.

Rule 7.—A register of the sample plot will be kept up in prescribed Form H.

Rule 8.—The percentages of growth for the periods intervening between successive enumerations will be calculated from the formula given on page 49 and by the graphic method, the results being published from time to time.

PRESCRIBED FORM H—REGISTER OF SAMPLE PLOTS TO DETERMINE THE RATE OF PASSING OVER FROM ONE GIRTH CLASS TO THE NEXT HIGHER.

*Name of Working Circle*________________________________

*Name of Felling Series*________________________________

*Civil District, Forest Circle and Province*____________________

Species ____

Name or number of Sample Plot.	Number of Compartment in which situated.	Area of Sample Plot.	Facts to be ascertained.	Date of first measurement.	Intervals at which measurements taken.	

Name or number of Sample Plot ______________________________

Area of Compartment ____________________ *acres.*

Species under observation ______________________________

AREA OF SAMPLE PLOT.			Species and nature of operations.	YEAR OF ENUMERATION OR RECORDING OF FELLINGS, ETC.		RESULTS OF				
						SOU				
						Girth				
Wooded area.	Blanks.	Total.		Month.	Year.	Below 18" and seedlings.	18"—36".	36"—54".	54"—72".	72"—90".
49	4	53	Deodar (enumeration).	July	1904	Many	1,000	680	440	...
			Blue pine (enumeration).	...	...	Do.	...	170	96	...

*Number of compartment in which situated*________________________

*Area of sample plot enumerated*____________ *acres.*

ENUMERATIONS.						REMARKS.
ND.		UNSOUND.				
classes.		Girth classes.				
90" and over.	Below 18" and seedlings.	18"—36".	36"—54".	54"—72".	Over 72".	
...	...	...	...	24	23	Enumeration results will be entered in black ink and records of fellings casualties, etc., in red ink.
...	...	...	...	5	4	

SECTION 4.—THE COLLECTION OF DATA RELATING TO THE RATE OF NATURAL THINNING AND TO THE EFFECTS OF ARTIFICIAL THINNINGS ON THE DEVELOPMENT OF A CROP.

(*i*) *Natural thinning.*

The rate of natural thinning in an even-aged crop will be readily deduced from the data collected in the manner explained in Chapter II, Section 2. The difference between the number of stems constituting the crop at different ages in an area not artificially thinned, that is in a crop from which only dead stems are removed, will represent the rate of natural thinning.

The manner of ascertaining the number of stems to be found per unit of area at different ages in an unthinned crop has already been fully explained in that section of this Note.

(*ii*) *The effect of artificial thinning on the development of single trees or whole crops.*

It has been seen that both in the case of the collection of data relating to the development of single stems and of whole even-aged woods, artificial thinnings may be prescribed. The effect respectively of a light, moderate, or heavy thinning on the girth, height, and volume increment of single trees or whole crops may be gauged by comparing the development of each of these factors in crops subjected to one or other of these conditions.

In order that a correct comparison may be made it will be necessary to establish adjoining areas exactly similar in composition ; one to be lightly, the other moderately, and the third heavily thinned in accordance with the definitions given on page 38 of this Note.

In other respects the collection of data in each experimental plot would be carried out on exactly the same lines as those set forth in Chapter II, Sections 1 and 2 of this Note ; care being taken that a sufficiently large number of stems, or area, is available in each case. No area less than half an acre in extent should be taken up for such plots.

CHAPTER III.

RELATING TO COPPICE WOODS.

SECTION 1.—DETERMINATION OF THE RATE OF GIRTH OR DIAMETER AND HEIGHT DEVELOPMENT OF SELECTED TYPE COPPICE SHOOTS, GROWING IN ARTIFICIALLY THINNED OR UNTHINNED CLUMPS.

Object of experiment.

The object of this experiment is to determine the development in height and girth of selected coppice shoots growing under definite conditions; and consequently the number of years required to produce shoots of given dimensions.

Method of procedure.

The object in view may be two-fold :—

(*a*) to determine the girth and height development of each of the coppice shoots produced on a selected stool; or

(*b*) to determine the girth and height development of selected coppice shoots produced on selected stools.

As the first case will not produce any definite results owing to the difficulty of distinguishing between shoots that can be profitably measured and stunted shoots that can never develop, the second case will here be considered, and only sufficiently well-developed shoots will be brought under observation.

The collection of data relating to the development of selected coppice shoots will be carried out in exactly the same manner as in the case of selected type seedling trees—*vide* Chapter II, Section 1 of this Note.

The measurements taken, and the calculations made therefrom, will likewise be recorded in prescribed registers, Forms I and J.

The age and girth of the stump, its condition, and the method of dressing adopted (cut flush with the ground, cut a few inches from the ground and trimmed conically, etc.) will be recorded.

Rules for measurement of type coppice shoots for observing girth and height development.

Rule 1.—The dominant and most vigorous coppice shoots in the area selected will be observed.

Rule 2.—Not more than 2 shoots on each stool will be selected for measurement, and at least 100 shoots of each species in every series of 5-year age gradations will be brought under observation.

Rule 3.—Each species will form the subject of a separate experiment, but the different species may be situated in one and the same coupe or compartment.

Rule 4.—Unless the coupe or compartment does not exceed 5 acres in extent, the selected shoots should be concentrated in a smaller area, such area being demarcated by a boundary ditch 2′ × 2′ and shown on the map.

Rule 5.—Type shoots will not be selected within a distance of half a chain of a road or ride, fire-line, blank or other clearing.

Rule 6.—Type shoots will be numbered by means of tin labels bearing stamped numbers tied on loosely with wire at about 5′ from the ground. The point of girth measurement will be denoted by a band of white paint round the shoot, the following details being observed :—

(*a*) The rings will be at right angles to the axis of the shoot.

(*b*) The rings will be more or less at breast height (4′6″) from the ground.

(*c*) A good band of white oxide paint will be used.

Rule 7.—The rings and tin labels will be renewed as often as required.

Rule 8.—If thinnings and cleanings are carried out in the areas in which type shoots are situated, the operations as regards their nature and intensity will be carefully recorded.

Measurements.

Rule 9.—The girths and heights of the type shoots will be measured in the same month yearly by a trained forest officer.

Rule 10.—All girth measurements will be made with a steel tape the upper edge of which will coincide with the upper edge of the ring of paint on the shoot. The measurements will be recorded in inches and decimals of inches.

Rule 11.—At each annual measurement individuals interfering with the development of the type shoot will be removed, so that the original conditions at time of selection may continue.

Rule 12.—The height of the type shoots will be measured by means of a levelling staff or a bamboo divided up into 6″ lengths ; the height being recorded at the same time as the girth measurement, in feet and half feet.

Register.

Rule 13.—Records of height and girth measurements of the type shoots will be kept in the prescribed register Form I, and from these figures the mean girth and height of the shoots at the end of each 5-year period will be calculated by the graphic method ; the results being entered in the prescribed register Form J and published from time to time either in this form, or by graphic representations.

PRESCRIBED FORM I—REGISTER OF SAMPLE PLOTS TO DETERMINE THE GIRTH AND HEIGHT DEVELOPMENT OF SELECTED COPPICE SHOOTS.

Name of Reserve, Range or Working Circle ____________

Civil District, Forest Circle and Province ____________

Name of Sample Plot ____________

Species.	Area of Number of shoots.	Facts to be ascertained.	Date of first measurement.	Intervals at which measurements taken.	Remarks.

Descriptive details.—Latitude, longitude, rainfall, elevation, soil, etc.

Age.	Serial number of shoot.	Number of coupe and Compartment.	Species.	MEASUREMENT ON 19			MEASUREMENT ON 19			MEASUREMENT ON 19			MEASUREMENT ON 19			MEASUREMENT ON 19		
				Girth.	Height.	Remarks.	Girth.	Height.	Remarks.	Girth.	Height.	Remarks.	Girth.	Height.	Remarks.	Girth.	Height	Remarks.

PRESCRIBED FORM J—CALCULATION OF THE MEAN GIRTH AND MEAN HEIGHT DEVELOPMENT OF SELECTED COPPICE SHOOTS.

INDEX.

Province.	Forest Division.	Name of Sample Plot.	Species.	Page.

*Name of Sample Plot*____________________

*Name of Forest Division*____________________

*Name of Province*____________________

Age.	Species.	Date of 19 .				Date of 19 .				Date of 19 .				Date of 19 .			
		Number of stools.	Number of shoots.	Mean Girth.	Mean Height.	Number of stools.	Number of shoots.	Mean Girth.	Mean Height.	Number of stools.	Number of shoots.	Mean Girth.	Mean Height.	Number of stools.	Number of shoots.	Mean Girth.	Mean Height.

SECTION 2.—THE DETERMINATION OF THE RATE OF GIRTH, HEIGHT, AND VOLUME INCREMENT OF PURE OR MIXED COPPICE WOODS, CLUMPS BEING ARTIFICIALLY THINNED OR UNTHINNED.

Object of Experiment.

The object of this experiment is to collect data suitable for the preparation of yield tables, showing for different qualities of locality the mean girth and the mean height of the shoots at different ages, as well as the volume which may be expected per unit of area with different rotations.

Selection of experimental plots.

In a systematically worked coppice forest, whether simple or with standards, the coppice age gradations occupy separate areas. In the selection of experimental plots, two procedures may therefore be followed—

(*a*) An experimental plot of convenient size may be laid out in certain of the age gradations : the crop on them felled, and the material measured up ; or

(*b*) One or more experimental plots may be laid out in suitable portions of the crop, and the development of the crop may be studied by taking measurements periodically.

As the second method involves minute measurements of a large number of stems, whose volume cannot be accurately ascertained, the first of these two methods will alone be made use of. Areas fully stocked with normally developed shoots, proceeding from sound, healthy stools will be selected ; and the manner in which the coppicing has been carried out, whether flush with the ground or at a given height from the ground, will be carefully indicated.

Experimental plots may be required for each species, or the development of a mixed crop may be studied.

Demarcation of experimental plot.

To carry out the experiment, it will be necessary to lay out plots of suitable size, not less than ½ an acre in extent, in as many of the different age gradations as can conveniently be dealt with. These plots only require to be temporarily demarcated, and this can be done in a variety of ways, *e.g.*, by means of flags and chains or ropes, or a temporary trench with posts at the corners.

Measurement of the crop.

(*i*) *Age of crop.*—The age of the crop would be known from records, and this age will be entered in the prescribed register.

(*ii*) *Area of experimental plot.*—The area of each of the experimental plots will be carefully recorded. In plots selected on sloping ground the actual sides will be measured and the angle of slope recorded.

(*iii*) *Number of shoots and Girth Measurements.*—Before the crop is felled an enumeration of the coppice shoots on the area will be carried out in 3-inch girth classes separately for each species. In this way the number of shoots on the area and the average girth of the shoots will be obtained and recorded in the prescribed register, Form K.

(*iv*) *Height.*—The height of the dominant shoots in the crop will be recorded separately for each species, and the average for each species calculated.

(*v*) *Height and Volume.*—After the mean girth at breast height and the average height has been calculated by measuring the standing crop the whole will be felled over and stacked in suitable grades.

The volume of the growing stock in solid cubic feet will be calculated according to the following classes, separately for each species, if local conditions make this necessary :—

(*a*) Material 6 inches and over in girth.
(*b*) Faggots from 3 inches and up to but not including 6 inches in girth.
(*c*) Brushwood below 3 inches in girth.
(*d*) Total of all classes.

Stacked cubic feet will be reduced to solid cubic feet by the use of coefficients to be determined by actual xylometer measurements ; the coefficients used will be recorded in the register.

(*vi*) *Calculation of mean annual increment.*—The total volume of the crop at any age divided by that age will give the mean annual increment.

Register of Plots.

All measurements taken in the sample plots of different ages to be felled over will be recorded in a register in prescribed Form K ; and they will be published from time to time as soon as sufficient data are available, after being reduced to the unit of area, the acre.

Thinnings.

In certain cases the removal of a proportion of the shoots produced on each stump may be prescribed in order to encourage the development of those left. In such a case the least promising and most backward of the shoots would be removed, either in one operation, once during the period of the rotation, or at given intervals of time.

If sample plots are selected from areas which have been thus thinned over, the fact will be clearly recorded in the register.

Rules relating to Sample Plots selected with the object of determining the mean girth, number of shoots, average height and mean volume per class of material, and total volume per unit of area, at different ages of pure or mixed coppice woods; the clumps being artificially thinned or not thinned.

Selection and Preparation of Plots.

Rule 1.—The plot will be of a suitable size, not less than half an acre in extent.

Rule 2.—The plot will be fully stocked with an even-aged crop of normally-developed shoots, produced from healthy stools.

Rule 3.—Each species will form the subject of a separate experiment unless the object is to determine the development of a mixed crop.

Rule 4.—The plot will be temporarily demarcated in the manner most convenient; usually by a trench with flags or posts at the corners. The shape of each sample plot will be rectangular. A board may also be erected indicating the name and number of the sample plot.

Rule 5.—Sample Plots will not be selected within ½ a chain from the edge of blank, road, or other clearing.

Rule 6.—The removal of any of the superfluous coppice shoots from each stump, if prescribed, will be carried out and the fact recorded in the register of the sample plot concerned, and the volume of the material removed, if known, will also be entered.

Measurements.

Rule 7.—All measurements relating to one sample area will be taken in one and the same month; and the results of such measurements will be entered in the prescribed register, Form K.

Rule 8.—All girth and height measurements will be taken before the crop is felled; the girth of each shoot being measured at breast height.

Rule 9.—The shoots will be enumerated in 3-inch girth classes; and therefrom the mean girth will be calculated.

Rule 10.—The height of the dominant shoots will be taken in feet and ½ feet by means of a levelling staff or bamboo and the average calculated for the plot for each species separately.

Rule 11.—The material obtained from the fellings will be measured up according to the following classes:—

(*a*) Material 6 inches and over in girth.

(*b*) Material from 3 and up to but not including 6 inches in girth.

(*c*) Material under 3 inches in girth.

Rule 12.—The volume of the larger pieces of material will be calculated from the midgirth and length; the volume of the remainder of the produce will be obtained by stacking the same and using reducing factors to get its solid content. Reducing factors will be calculated from actual xylometer measurements.

Rule 13.—By dividing the total volume of the crop in solid cubic feet by its age, the Mean Annual Increment will be obtained.

(*iii*) *Record of Observations.*

Rule 14.—All measurements taken will be recorded in a prescribed register in Form K; and the data so collected will be published from time to time after collating and reducing all measurements to the unit, the acre.

PRESCRIBED FORM K—REGISTER OF SAMPLE PLOTS TO DETERMINE THE VOLUME OF COPPICE CROPS OF DIFFERENT AGES.

Name of Reserve, Range or Working Circle—

Civil District, Forest Circle, and Province—

Serial No.	Species.	Number of		Area of plot.	Facts to be ascertained.	Date of making measurements.	Remarks.
		Compartment.	Coupe.				

RECORD OF

Year of measurement.	Number of		Age of crop.	Area.	Species	Number of stools.	Number of shoots.	Girth of mean shoot at 4½′ from ground in inches.	Mean height of crop in feet.
	Compartment.	Coupe.							

MEASUREMENTS.

Volume of growing stock in cubic feet solid.					Remarks.
Material over 6 inches girth cubic feet solid.	Material 3 to 6 inches girth cubic feet solid.	Material under 3 inches girth cubic feet solid.	Total of all classes cubic feet solid.	M. A. I. in cubic feet solid.	

PROBLEMS RELATING TO THE COLLECTION OF STATISTICAL DATA AT PRESENT UNDER INVESTIGATION IN EACH PROVINCE: TABLE OF EXISTING EXPERIMENTAL PLOTS.

APPENDIX.

The statement which follows deals briefly with plots already in existence in the various provinces of British India outside the Madras and Bombay Presidencies for the purpose of gathering statistical information. This will at once show how little has been accomplished and how much more extended the operations have to be to obtain tangible and reliable results.

In the past, all such experimental work has been carried out by local officers under varying conditions. But with the view of fully utilising the services of Research officers in the future it is thought that, provided Local Conservators offer no objection, a good deal of the field work in connection with the collection of statistics, namely, the inauguration of experimental plots, their periodic inspection and measurement, the determination of their utility and the period over which they should be maintained, etc., should be carried out by Research officers in the course of their annual tours. This will not only relieve the overburdened Divisional Forest Officer but will also tend to an increased uniformity of working and measurement of sample plots throughout the Empire.

Problems relating to the collection of statistical data at present

1. Relating to Sal

Problems under investigation.	Name of Province or Forest Circle.	Name of Forest Division.
I. To determine rate of girth increment.	1. Punjab	Simla
	2. United Provinces	i. Siwalik (Dehra Dun).
		ii. Siwalik (Saharanpur).
		iii. Ganges
		iv. Garhwal
		v. Kumaon
		vi. Pilibhit
		vii. Kheri
		viii. Bahraich
		ix. Gonda
		x. Gorakhpur
	3. Bengal	i. Darjeeling
		ii. Tista
		iii. Kurseong
		iv. Sonthal Parganas
		v. Palamau
		vi. Singhbhum
		vii. Puri
		viii. Angul
		ix. Sambalpur

under investigation in each Province: Existing Experimental Plots.

(*Shorea robusta*).

Name of Reserve or Working-Circle.	Number of Sample Plots.	REMARKS.
......	2	
......	7	
......	3	
......	7	
.....	5	
......	13	
......	5	
......	18	
......	11	
......	4	
......	46	
......	3	
......	4	
......	7	
.....	3	
......	3	
......	4	
... ..	4	
......	5	
......	4	

1. **Relating to Sal**

Problems under investigation.	Name of Province or Forest Circle.	Name of Forest Division.
	4. Eastern Bengal and Assam.	i. Jalpaiguri . . ii. Buxa . . . iii. Goalpara . . . iv. Garo Hills . .
	5. Central Provinces.	Balaghat . . .

2. **Relating**

I. To determine rate of girth growth in protected forests.	1. Central Provinces.	i. Bhandara . . .
	2. Burma . .	i. Bhamo . . .
II. To determine rate of girth growth in burnt areas.	1. Burma . .	i. Bhamo . . .
III. To determine rate of girth growth in plantations.	1. Burma . .	i. Zigon . . . ii. Thaungyin . .

3. **Relating to Deodar,**

I. To determine the most suitable degree of intensity of thinning in order to obtain great volume increment.	1. North-West Frontier Province.	i. Hazara . . .
	2. Punjab . .	i. Simla . . . ii. Chamba . . . iii. Kulu . . .

4. **Relating to**

I. To determine the most suitable degree of intensity of thinning.	1. Punjab . .	i. Simla . . .

(*Shorea robusta*)—*contd.*

Name of Reserve or Working-Circle.	Number of Sample Plots.	Remarks.
……	2	
……	5	
……	6	
……	6	
……	6	

to Teak.

…	1	
…	2	
…	2	
… …	2 1	

(*Cedrus Deodara*).

…	2	
… … …	1 1 1	

Pinus excelsa.

…	2	

5. Relating to

Problems under investigation.	Name of Province or Forest Circle.	Name of Forest Division.
I. To determine the rate of girth and height growth.	1. Eastern Bengal and Assam.	i. Khasi and Jaintia Hills.

6. Relating to Burma

I. To determine the rate of girth and height growth.	1. Burma . .	i. Pyinmana . . .

Pinus khasya.

Name of Reserve or Working-Circle.	Number of Sample Plots.	REMARKS.
...	4	

"Indaing Species."

...	5	

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UNIV. OF MICHIGAN
MAR 20 1910

TABLES SHOWING THE PROGRESS IN WORKING PLANS

IN THE PROVINCES OUTSIDE THE MADRAS AND BOMBAY PRESIDENCIES UP TO THE 31st DECEMBER 1908

WITH SPECIAL REFERENCE TO THE APPLICATION OF THE VARIOUS SYLVICULTURAL SYSTEMS

Compiled by

A. M. F. CACCIA, I.F.S., M.V.O., F.Z.S.,
Imperial Superintendent of Forest Working Plans
and Imperial Sylviculturist

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TABLES SHOWING THE PROGRESS IN WORKING PLANS

IN THE PROVINCES OUTSIDE THE MADRAS AND BOMBAY PRESIDENCIES UP TO THE 31st DECEMBER 1908

WITH SPECIAL REFERENCE TO THE APPLICATION OF THE VARIOUS SYLVICULTURAL SYSTEMS

INTRODUCTION.

THE area under the control of the Forest Department on the 31st December 1908 in the provinces of British India outside the Madras and Bombay Presidencies was reported to be 131,302,506 acres, or approximately 205,160 square miles: 20,369,009 acres, or 15·5 per cent., of this total area having been brought under systematic working in accordance with the provisions of regular sanctioned working plans.

In the tables, which form the substance of this pamphlet, these figures are analyzed. The total forest area corrected up to the 31st December 1908 is shown by Forest Divisions, together with full details regarding the areas for which working plans have been completed and sanctioned : the area dealt with by each working plan being classified according to the sylvicultural system adopted. In this place, it will be sufficient to briefly summarize the information contained in the tables.

The following statement gives by Forest Circles the areas brought under the control of sanctioned working plans up to the 31st December 1908 in the provinces outside the Madras and Bombay Presidencies :—

Province.	Circle.	FOREST AREA IN ACRES.					Area for which working plans have been prepared and sanctioned up to 31st December 1908.	Proportion of forest area under sanctioned working plans.
		Reserved.	Leased.	Protected.	Unclassed.	Total.		
							Acres.	Per cent.
Bengal .	...	2,710,587	...	1,787,792	...	4,498,379	3,256,393	72
United Provinces.	Eastern Circle.	1,357,830	...	2,729	18,928	1,379,487	1,161,853	84
	Western Circle.	1,160,399	100,399	16,757	7,416	1,285,001	1,237,807	96
	Total .	2,518,229	100,399	19,486	26,374	2,664,488	2,399,660	90
Punjab .	...	1,156,286	236,199	3,354,308	1,102,107	5,848,900	2,568,376	44
Lower Burma.	Tenasserim Circle.	3,256,232	...	...	17,004,781	20,261,013	1,143,887	6
	Pegu Circle	4,025,034	...	...	16,297,441	20,322,475	1 070,485	5
Upper Burma.	Southern Circle.	3,975,583	...	...	20,547,497	24,523,080	1,364,438	5
	Northern Circle.	3,372,545	...	...	15,012,338	18,384,883	24,320	·13
	Total .	14,629,394	...	...	68,862,057	83,491,451	3,603,130	4

Province.	Circle.	FOREST AREA IN ACRES.					Area for which working plans have been prepared and sanctioned up to 31st December 1908.	Proportion of forest area under sanctioned working plans.
		Reserved.	Leased	Protected.	Unclassed.	Total.		
							Acres.	Per cent.
Eastern Bengal and Assam.	...	4,195,841	...	2,507	14,511,311	18,709,669	706,786	4
Central Provinces including Berar.	Southern Circle.	4,878,909	...	...	...	4,878,909	3,582,203	73
	Northern Circle.	4,715,083	...	...	1,791	4,716,874	2,496,906	69
	Berar Circle.	4,485,818	...	...	...	4,485,818	1,400,769	31
	Total .	14,079,810	...	...	1,791	14,081,601	7,479,878	53
Coorg .	...	332,926	..	...	...	332,926	113,727	34
North-West Frontier Province.	...	151,279	...	.	...	151,279	151,279	100
Ajmer .	...	90,679	...	115	3,471	94,265	89,730	95
Baluchistan	...	179,469	...	...	...	179,469	...	...
Andamans	...	101,930	...	...	1,148,149	1,250,079	...	...
GRAND TOTAL .		40,146,430	336,598	5,164,208	85,655,260	131,302,506	20,369,009	15·5

The total area under the control of sanctioned working plans being thus equal to 20,369,009 acres, the following statement shows the allotment of this area to the various sylvicultural systems; as well as the proportion of the total area under each method of treatment—

Sylvicultural System.	Area in acres.	Equivalent in square miles.	Percentage of total area under each sylvicultural system.
Method of Clear Fellings by compartments.	24,517	38	·1
Method of Clear Fellings by strips	...	...	...
Uniform method . . .	112,702	176	·5
Group method	48,474	75	·2
Selection method . . .	6,614,034	10,334	32·5
Storeyed forest method . .	...	...	...
Simple Coppice. . . .	81,482	127	·4
Coppice with standards . .	1,617,052	2,527	7·9
Method of Improvement Fellings	5,210,501	8,141	25·7
Unregulated Fellings or Unworked	6,660,246	10,407	32·7
TOTAL .	20,369,009	31,825	100

With few slight exceptions, the method of clearances, the uniform, and the group methods have not so far been applied to any extent in any of the forests of India. The method of clearances has been attempted in the Darjeeling forests (Bengal) with remarkable success; and the uniform method has been found to be entirely suited to the Chir (*Pinus longifolia*) forests of the United Provinces to which it has been largely extended. Steps are also being taken to apply this method of successive regeneration fellings to some of the Sal forests of the Kumaun Division in the United Provinces; the Sal, being a species which would seem to be well adapted to this method of treatment in all the highest quality localities and where excessive frosts are not to be feared. The method is also to be given a trial in the Mohnyin pure teak forest of Upper Burma; and it is probable that it will be extended in the near future to the Terai Sal forests of Bengal.

The Coppice method, the Selection method and the so-called method of Improvement fellings are, however, the ones which have received their widest application in India. The former method is eminently adapted to all village forests and fuel reserves, where the object of management is to produce small poles and brushwood for the use of the surrounding peasantry; the standards moreover supplying the necessary shelter and seed, as well as a certain quantity of wood of larger dimensions.

Under the conditions usually prevailing in Indian high forests, when large areas have to be dealt with, where in a mixed forests only one species is marketable, where the crop is irregular and only trees of large dimensions are saleable, when owing to local conditions it appears to be dangerous or inadvisable to interrupt the cover, and when a trained establishment is not available, the selection method is generally indicated. When in addition the forest is in a ruined condition, the age-classes are badly represented, and the object of management is to remove the overmature, dead and dying trees, whilst allowing the younger age classes to grow up under favourable conditions, the so-called *"Method of Improvement fellings"* is prescribed: the latter method being also known as the *"Selection method by areas,"* combined with sylvicultural operations for the benefit of the principal crop.

The calculation of the possibility under the selection method has received considerable attention in India, and the methods employed have been fully set forth in a Note recently published in the Indian Forest Records.*

The forests dealt with in a regular working plan usually include areas which are unworkable, either on account of their inaccessibility or the unproductiveness of the ground; or, on account of want of demand. Such areas are either closed to all working as "protection forests," or the small amount of usually inferior material required from them, to an extent far below the possibility of the forests, is removed under the general orders and supervision of the Conservator by means of operations usually described as *"Unregulated Fellings."* It will be seen that a considerable area in many of the more remote forests, where only a few trees of the valuable species are exploitable, falls into this class.

The tables which follow are corrected up to the 31st December 1908. They will require to be revised from time to time as additional areas are brought under systematic working, or whenever owing to the expiry and revision of an existing plan, the method of treatment comes to be altered.

---

* The Selection System in Indian Forests as exemplified in working plans based on this system. By A. M. F. Caccia. Indian Forest Records, Volume I, Part IV.

Table I.

SHOWING THE PROGRESS MADE IN WORKING PLANS WITH SPECIAL REFERENCE TO THE APPLICATION OF THE VARIOUS SYLVICULTURAL SYSTEMS.

Name of Province	Name of Conservator's Circle	FOREST DIVISION.					DETAILS OF			
				AREA IN ACRES.						
		Name of Forest Division.	Class of Forest.	Under Working Plans.	Without Working Plans.	Total Forest area of Division.	Name of Working Plans relating to each Forest Division.	Principal species dealt with.	Number of Working Circles.	Number of Felling Series.
								NORTH-WEST		
North-West Frontier Province.		Hazara . .	...	151,279	...	151,279	Kagan range forests	Deodar; Pinus longifolia; P. excelsa; Abies Webbiana; etc.	2	...
							Siran range forests	Pinus longifolia, P. excelsa; Abies Webbiana; etc.	2	...
							Dungagali and Tandiani range forests.	Oak; P. longifolia; P. excelsa; Deodar; etc.	4	...
							Khanpur range forests.	Pinus longifolia; Dodonœa Viscosa; Prinsepia utilis; Acacia modesta; A. catechu; Olea cuspidata; Pistacia intergerrima.	2	...
		GRAND TOTAL	...	151,279	...	151,279	...	..	...	...
									PUN	
Punjab.	Punjab.	Rawalpindi .	Reserved . Protected. Unclassed	160,100 48,665 ...	51,195 ... 229,137	211,295 48,665 229,137	Kalachitta Forests	Olive, Acacia . .	8	...
							Murree-Kahuta Forests.	...	7	...
		Total .	...	208,765	280,332	489,097	...	...	...	...
		Kangra .	Reserved . Protected. Unclassed	35,282 473,378 278,237	... ...	35,282 473,378 278,237	Kangra Forest Division.	...	7	14
		Total .	...	786,897	...	786,897	...	...	...	...
		Kulu . .	Reserved . Protected.	42,981 1,274,880	.. 2,306	42,981 1,277,186	Kulu Forest Division.	Deodar; P. longifolia; P. excelsa; Picea Morinda; Abies Webbiana; etc.	4	...
		Total .	...	1,317,861	2,306	1,320,167	...	...	...	...
		Bashahr .	Leased . Reserved .	145,920 ...	90,279 417	236,199 417	Bashahr Leased Sutlej Valley Forests.	Deodar; Pinus excelsa; etc.	4	...
		Total .	...	145,920	90,696	236,616	...	...	...	...

WORKING PLANS.

Area in acres under different Sylvicultural Systems.											Period of each Working Plan.	Remarks.
Method of Clear Fellings by Compartments with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method of Successive Regeneration Fellings.	Group Method.	Selection Method.	Storeyed Forest Method.	Simple Coppice Method.	Coppice with Standards Method.	Method of Improvement Fellings.	Area under Unregulated Fellings or Unworked.	Grand Total.		
FRONTIER PROVINCE.												
...	...	...	...	41,154	...	...	...	7,749	...	48,903	1900-01 to 1939-40.	
...	...	...	...	29,804	...	...	...	...	...	29,804	1905-06 to 1936-37.	
...	...	...	...	38,069	...	...	1,714	...	...	39,783	1905-06 to 1928-29.	
...	...	...	...	5,385	...	...	27,404	...	...	32,789	1906-07 to 1920-21.	
...	...	...	...	114,412	...	...	29,118	7,749	...	151,279		
JAB.												
...	...	...	...	...	...	...	45,617	...	47,394	93,011	1896-97 to 1925 26.	
...	...	...	47,595	...	...	...	...	7,709	60,450	115,754	1899-1900 to 1928-29.	
...	...	...	47,595	...	...	...	45,617	7,709	107,844	208,765		
...	...	..	...	145,140	...	...	408,495	213,487	19,775*	786,897	...	* Bamboo Circle.
...	...	...	...	145,140	...	...	408,495	213,487	...	786,897		
...	...	...	...	1,159,280	...	...	...	158,581	...	1,317,861	1897-98 to 1931-32.	
...	...	...	...	1,159,280	...	...	...	158,581	...	1,317,861		
...	...	...	...	95,491	...	...	...	10,241	40,188	145,920	1905-06 to 1934-35.	
...	...	...	..	95,491	...	...	...	10,241	40,188	145,920		

Name of Province.	Name of Conservator's Circle.	FOREST DIVISION.					DETAILS OF			
		Name of Forest Division.	Class of Forest.	AREA IN ACRES.			Name of Working Plans relating to each Forest Division.	Principal species dealt with.	Number of Working Circles.	Number of Felling Series.
				Under Working Plans.	Without Working Plans.	Total Forest area of Division.				
									PUN	
Punjab.	Punjab.	Simla .	Reserved .	20,338	...	20,338	Kalesar Reserved Forests.	Sal; etc. . . .	2	...
			Unclassed	2,195	...	2,195	Simla Municipal Forests.	Deodar; Oak; Pinus longifolia; Rhododendron; etc.	4	...
							Simla Catchment Area Forests.	Deodar; Oak; Pinus excelsa; Picea Morinda.	3	...
							Kotkhai, Kotguru Reserved Forests.	...	2	...
		Total .	...	22,533	...	22,533	...	...	...	...
		Lahore .	Reserved .	14,080	6,516	20,596	Changa Manga Plantation.	Dalbergia Sissoo; Morus indica.	1	...
			Protected.	...	7,911	7,911	Shahdera-Cum-Jhugion Plantation.	...	1	...
			Unclassed.	...	75,910	75,910				
		Total .	...	14,080	90,337	104,417	...	...	...	...
		Multan .	Reserved .	72,320	13,213	85,533	South Kabirwala and Mailsi Forests.	...	2	...
			Protected.	...	1,537,928	1,537,928				
			Unclassed.	...	17,903	17,903				
		Total .	...	72,320	1,569,044	1,641,864	...	...	...	...
		Jhelum .	Reserved .	..	191,070	191,070	...	...	...	...
			Unclassed.	...	62,008	62,008	...	...	...	...
		Total .	...	...	253,078	253,078	...	...	...	...
		Chenab .	Reserved .	...	67,883	67,883	...	...	...	...
			Unclassed.	...	4,105	4,105	...	...	...	...
		Total	..	.	71,988	71,988	...	...	...	...
		Montgomery .	Reserved .	...	64,863	64,863	...	...	...	...
			Unclassed.	...	391,669	391,669	...	...	...	...
		Total .	...	...	456,532	456,532	...	...	...	...

WORKING PLANS.

AREA IN ACRES UNDER DIFFERENT SYLVICULTURAL SYSTEMS.												
Method of Clear Fellings by Compartments with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method of Successive Regeneration Fellings.	Group Method.	Selection Method.	Storeyed Forest Method.	Simple Coppice Method.	Coppice with Standards Method.	Method of Improvement Fellings.	Area under Unregulated Fellings or Unworked.	Grand Total.	Period of each Working Plan.	REMARKS.
JAB—*contd.*												
...	...	...	...	...	...	1,814	...	6,755	1,404	9,973	1898-99 to 1922-23.	
...	...	...	...	...	...	...	127	2,034	...	2,161	1897-98 to 1926-27.	
...	...	...	...	...	...	...	263	1,719	...	1,982	1896-97 to 1919-20.	
...	...	...	...	...	...	...	...	8,417	...	8.417	1901-02 to 1920-21.	
...	...	...	...	...	...	1,814	390	18,925	1,404	22,533		
...	...	...	...	...	..	...	10,332	...	960	11,292	1896-97 to 1910-11.	
...	...	...	...	...	...	...	1.828	...	960	2,788	1901-02 to 1915-16.	
...	...	...	...	...	...	...	12,160	...	1,920	14,080		
...	...	...	...	...	...	72,320	...	...	...	72,320	1897-98 to 1920-21.	
...	...	...	...	...	...	72,320	...	...	...	72,320		
... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	
...	...	...	...	...	...	...	...	...	...	...		
... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	
...	...	...	...	...	...	...	...	...	...	...		
... ...	... ...	... ...	... ...	... ...	...	... ..	... ...	... ...	... ...	... ...	... ...	
...	...	...	...	...	...	...	...	...	...	...		

Name of Province.	Name of Conservator's Circles.	FOREST DIVISION.					DETAILS OF			
		Name of Forest Division.	Class of Forests.	AREA IN ACRES.			Name of Working Plans relating to each Forest Division.	Principal species dealt with.	Number of Working Circles.	Number of Felling Series.
				Under Working Plans.	Without Working Plans.	Total Forest area of Division.				
									PUN	
Punjab.	Punjab.	Shahpur	Reserved	...	401,369	401,369	...	...	...	...
			Unclassed	...	21,060	21,060	...	...	...	...
		Total	...	...	422,429	422,429	...	...	...	...
		Pir Mahal	Reserved	...	14,659	14,659	...	...	4	...
			Protected	...	9,240	9,240	...	...	1	...
			Unclassed	...	19,883	19,883	...	...	1	...
		Total	...	...	43,782	43,782	...	...	...	...
		GRAND TOTAL	...	2,568,376	3,280,524	5,848,900	...	...	...	...
									UNITED	
United Provinces.	Western Circle.	Naini Tal	Reserved	79,855	27,677	107,532	Naini Tal Sub-Divisional Forests.	Pinus longifolia; Oak; Sal; etc.	12	...
			Protected	16,757	...	16,757	Naini Tal Municipal Forests.	Oak; Pinus longifolia; Pieris ovalifolia; Rhododendron arboreum; etc.	...	...
							Naini Tal Cantonment Forests.	...	...	...
							Ranikhet Sub-Divisional Forests.	Pinus longifolia; Oak; Pieris ovalifolia; Rhododendron; etc.	17	...
							Ranikhet Cantonment Forests.	Pinus longifolia; Oak; etc.	...	...
							Muktesar Reserved Forests.	Oak; Pinus longifolia; etc.	1	...
		Total	...	96,612	27,677	124,289	...	...	...	...
		Garhwal	Reserved	308,341	5,247	313,588	Garhwal Forest Division.	Sal; T. tomentosa; Anogeissus latifolia; etc.	6	2
							Behar Garibul Chand Forests.	Sal; Terminalia tomentosa; etc.	2	...
		Total	...	308,341	5,247	313,588	...	...	...	...
		Ganges	Reserved	275,494	6,824	282,318	Ganges Forests Division.	Sal; Terminalia tomentosa; Dalbergia Sissoo; etc.	7	...
							Lansdowne Reserved Forests.	Sal; Pinus longifolia; etc.	2	...
		Total	...	275,494	6,824	282,318	...	...	...	...

WORKING PLANS.

AREA IN ACRES UNDER DIFFERENT SYLVICULTURAL SYSTEMS.												
Method of Clear Fellings by Compartments with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method of Successive Regeneration Fellings.	Group Method.	Selection Method.	Storeyed Forest Method.	Simple Coppice Method.	Coppice with Standards Method.	Method of improvement Fellings.	Area under Unregulated Fellings or Unworked.	Grand Total.	Period of each Working Plan.	REMARKS.
JAB—concld.												
... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	
...	...	...	...	...	...	...	...	...	...	...	...	
... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...		
...	...	...	...	..	...	...	...	...	...	...	...	
...	...	...	47,595	1,399,911	...	74,134	466,662	408,943	171,131	2,568,376	...	
PROVINCES.												
...	...	...	...	47,742	...	...	3,706	...	...	51,448	1896-97 to 1915-16	
...	...	...	...	...	...	...	...	...	...	...		
...	...	...	...	...	...	...	...	...	...	...		
...	...	17,392	...	25,737	...	...	...	...	...	43,129	1898-99 to 1917-18.	
...	...	...	...	...	...	...	...	...	...	...		
...	...	...	...	2,035	...	...	...	...	...	2,035	1900-01 to 1919-20.	
...	...	17,392	...	75,514	...	...	3,706	...	...	96,61		
...	...	...	...	40,914	...	...	...	148,682	78,223	267,819	1893-94 to 1914-15.	
...	...	...	...	...	...	...	...	40,522	...	40,522	1894-95 to 1913-14.	
...	...	...	...	40,914	...	...	...	189,204	78,223	308,841		
...	...	...	...	28,462	...	7,348	...	195,283	32,931	264,024	1893-94 to 1914-15.	
...	...	...	...	3,494	...	...	...	7,976	...	11,470	1904-05 to 1933-34.	
...	...	...	...	31,956	...	7,348	...	203,259	32,931	275,494		

UNITED

Name of Province.	Name of Conservator's Circle.	FOREST DIVISION.					DETAILS OF			
		Name of Forest Division.	Class of Forest.	AREA IN ACRES.			Name of Working Plans relating to each Forest Division.	Principal species dealt with.	Number of Working Circles.	Number of Felling Series.
				Under Working Plans.	Without Working Plans.	Total Forest area of Division.				
United Provinces—*contd.*	Western Circle—*contd.*	Sewalik	Reserved	365,926	...	365,926	Dehra Dun Forests	Sal; Dalbergia Sissoo; Acacia Catechu; etc.	8	16
			Unclassed	...	7,446	7,446	Berkala, Dholkhand and Ranipur Ranges.	Sal; Terminalia tomentosa; Cedrela Toona; etc.	4	4
		Total	...	365,926	...	373,372	...	...	...	...
		Jaunsar					Jaunsar-Bawar Forests.	Deodar; Pinus longifolia; P. excelsa; Oaks; Picea Morinda; Sal, etc.	12	...
			Reserved	91,035	...	91,035	Tehri-Garhwal leased Chir Forests.	Pinus longifolia; etc.	1	...
			Leased	100,399	...	100,399	Tehri-Garhwal leased Deodar Forests.	Deodar, etc.	3	8
		Total	...	191,434	...	191,434	......	......	...	...
		GRAND TOTAL	...	1,237,807	47,194	1,285,001	......	......	...	...
	Eastern Circle.	Kumaun	Reserved	333,672	2,731	336,403	Kumaun Forest Division.	Sal, etc.	10	2
		Total	...	333,672	2,731	336,403			...	...
		Pilibhit	Reserved	133,302	...	133,302	Pilibhit Open Forests.	Sal, etc.	2	7
							Pilibhit Closed Forests.	Sal, etc.	2	4
							Surai-Banbasa Forests.	Sal, etc.	3	...
		Total	...	133,302	...	133,302			...	...
		Kheri	Reserved	266,429	21,559	287,988	Bhira Range (Hirapur Working Circle).	Sal, etc.	5	...
							Bhira Range Forests.	Sal, Terminalia tomentosa; etc.	3	...
							Trans-Sarda Forests.	Sal, etc.	5	...
		Total	...	266,429	21,559	287,988	......	......	...	...

WORKING PLANS.

AREA IN ACRES UNDER DIFFERENT SYLVICULTURAL SYSTEMS.												
Method of Clear Fellings by Compartments with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method of Successive Regeneration Fellings.	Group Method.	Selection Method.	Storeyed Forest Method.	Simple Coppice Method.	Coppice with Standards Method.	Method of Improvement Fellings.	Area under Unregulated Fellings or Unworked	Grand Total.	Period of each Working Plan.	REMARKS.
PROVINCES—*contd.*												
...	...	641	879	39,267	...	...	17,227	119,485	...	177,499	1903-04 to 1926-27.	
...	...	...	...	...	...	...	25,522	10,112	152,793	188,427	1908-09 to 1937-38.	
...	...	641	879	39,267	...	...	42,749	129,597	152,793	365,926		
...	...	33,626	...	55,705	...	...	9,240	...	...	98,571	1900-01 to 1939-40.	
...	...	33,000	...	...	...	...	...	...	10,100	43,100	1895-96 to 1925-26.	
...	...	3,307	...	31,624	...	...	...	...	14,832	49,763	...	
...	...	69,933	...	87,329	...	...	9240	...	24,932	191,434	1905-06 to 1944-45.	
...	...	87,966	879	274,980	...	7,348	55,695	522,060	288,879	1,237,807	...	
...	...	...	...	202,342	...	...	...	60,144	71,186	333,672	1892-93 to 1936-37.	
...	...	...	...	202,342	...	...	...	60,144	71,186	333,672	...	
...	...	...	...	...	...	...	50,420	...	...	50,420	1902-03 to 1933-34.	
...	...	...	...	...	...	...	14,971	16,048	14,104	45,123	1907-08 to 1933-34.	
...	...	...	...	1,610	...	...	...	11,400	24,749	37,759	1901-02 to 1910-11.	
...	...	...	...	1,610	...	...	65,391	27,448	38,853	133,302	...	
...	...	...	...	...	...	...	23,395	11,478	12,674	47,547	1896-97 to 1917-18.	
...	...	...	...	...	...	...	29,648	15,721	2,681	48,050	1894-95 to 1917-18.	
...	...	...	...	170,832	...	...	...	...	...	170,832	1903-04 to 1932-33.	
...	...	...	...	170,832	...	...	53,043	27,199	15,355	266,429	...	

Name of Province.	Name of Conservator's Circle.	FOREST DIVISION.					DETAILS OF			
		Name of Forest Division.	Class of Forest.	AREA IN ACRES.			Name of Working Plans relating to each Forest Division.	Principal species dealt with.	Number of Working Circles.	Number of Felling Series.
				Under Working Plans.	Without Working Plans.	Total Forest area of Division.				
									UNITED	
United Provinces.—*concld.*	Eastern Circle.	Bahraich	Reserved	213,944	...	213,944	Motipur Range Forests.	Sal, etc.	5	...
							Chakia-Charda Forests.	Sal, etc.	4	...
							Bhinga Range Forests	Sal, etc.	5	...
		Total	...	213,944	...	213,944	...	...	...	...
		Gonda	Reserved	103,785	...	103,785	Tikri Forests	Sal, etc.	1	...
							Tulsipur Forests	Sal, etc.	5	...
		Total	...	103,785	...	103,785	...	...	...	...
		Gorahkpur	Reserved	110,721	...	110,721	Gorakhpur Forests.	...	7	...
		Total	...	110,721	...	110,721	...	...	...	...
		Bundelkhand	Reserved	...	171,687	171,687	...	...	...	...
			Protected	...	2,729	2,729	...	...	...	...
			Unclassed	...	18,928	18,928	...	...	...	...
		Total	...	...	193,344	193,344	...	...	...	...
		GRAND TOTAL	...	1,161,853	217,634	1,379,487	...	...	...	...
		GRAND TOTAL	...	2,399,660	264,828	2,664,483	...	...	...	...
										BEN
Bengal.	Bengal.	Darjeeling	Reserved	24,736	50,283	75,019	Darjeeling Forests	Oak, Chestnut, Michelia Champaca, etc.	4	7
		Total	...	24,736	50,283	75,019	...	...	...	...
		Tista	Reserved	141,611	...	141,611	Tista Division Forests.	Sal; Cedrela Toona; Walnut; Bucklondia populnea; Oak; etc.	6	10
		Total	...	141,611	...	141,611	...	...	...	...

WORKING PLANS.

Area in acres under different Sylvicultural Systems.												
Method of Clear Fellings by Compartments with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method of Successive Regeneration Fellings.	Group Method.	Selection Method.	Storeyed Forest Method.	Simple Coppice Method	Coppice with Standards Method.	Method of Improvement Fellings.	Area under Unregulated Fellings or Unworked.	Grand Total.	Period of each Working Plan.	Remarks.
PROVINCES—*concld.*												
...	...	...	...	...	...	...	...	42,163	78,220	120,383	1893-94 to 1907-08.	
...	...	...	...	...	...	...	4,245	11,863	7,652	23,760	1895-96 to 1914-15.	
...	...	...	...	...	...	...	...	23,108	46,693	69,801	1893-94 to 1907-08.	
...	...	...	...	...	...	...	4,245	77,134	132,565	218,944	...	
...	...	...	...	...	...	...	13,456	...	...	13,456	...	
...	...	...	...	44,286	...	...	...	...	46,043	90,329	1900-01 to 1919-20.	
...	...	...	...	44,286	...	...	13,456	...	46,043	103,785	...	
...	...	...	...	...	...	...	25,995	40,470	44,256	110,721	1893-94 to 1912-13.	
...	...	...	...	...	...	...	25,995	40,470	44,256	110,721	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	419,070	...	...	162,130	232,395	348,258	1,161,853	...	
..	...	87,966	879	694,050	...	7,348	217,825	754,455	637,137	2,399,660	...	
GAL.												
...	...	24,736	...	...	...	...	...	...	...	24,736	1902-03 to 1911-12.	
...	...	24,736	...	...	...	...	...	...	...	24,736	...	
...	...	...	...	129,356	...	...	12,255	...	...	141,611	1906-07 to 1920-21.	
...	...	...	...	129,356	...	...	12,255	...	...	141,611	...	

Name of Province.	Name of Conservator's Circle.	FOREST DIVISION.					DETAILS OF			
		Name of Forest Division.	Class of Forest.	Area in acres.			Name of Working Plans relating to each Forest Division.	Principal species dealt with.	Number of Working Circles.	Number of Felling Series.
				Under Working Plans.	Without Working Plans.	Total Forest area of Division.				
										BEN
Bengal—*contd.*	Bengal—*contd.*	Kurseong .	Reserved .	68,082	...	68,082	Kurseong Reserved Forests.	Sal, etc. . . .	2	8
		Total .	...	68,082	...	68,082	...	...	...	...
		Palamau .	Reserved . Protected .	... ...	156,769 20,780	156,769 20,780	...	...	...	...
		Total.	...	...	177,549	177,549	...	...	...	...
		Singhbhum .	Reserved . Protected	463,847 ...	1,098 112,856	464,945 112,856	Singhbhum Reserved Forests.	Sal, etc. . .	6	6
		Total .	...	463,847	113,954	577,801	...	......	...	...
		Sambalpur .	Reserved .	44,606	208,553	253,159	Barapahar Range Forests.	......	2	9
		Total .	...	44,606	208,553	253,159	...	.....	...	...
		Angul . .	Reserved .	...	146,801	146,801	Angul Forests .	Sal, etc. . .	4	4
		Total .	...	...	146,801	146,801	...	......	...	...
		Puri . .	Reserved . Protected.	72,489 ...	... 231,218	72,489 231,218	Puri Reserved Forests.	Sal, etc. . .	3	16
		Total .	...	72,489	231,218	303,707	...	......	...	...
		Sundarbans .	Reserved . Protected	1,331,712 1,109,310	... ...	1,331,712 1,109,310	Sundarbans Division Forests.	Heritiera minor, etc.	4	4
		Total .	...	2,441,022	...	2,441,022	...	......	...	...
		Sonthal Parganas.	Protected	...	186,827	186,827	...	......	...	...
		Total .	...	...	186,827	186,827	...	.....	...	...

WORKING PLANS.

Method of Clear Fellings by Compartments with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method of Successive Regeneration Fellings.	Group Method.	Selection Method.	Storeyed Forest Method.	Simple Coppice Method.	Coppice with Standards Method.	Method of Improvement Fellings.	Area under Unregulated Fellings or Unworked.	Grand Total.	Period of each Working Plan.	Remarks.
AREA IN ACRES UNDER DIFFERENT SYLVICULTURAL SYSTEMS.												
GAL—*contd.*												
...	...	...	...	68,082	...	...	...	...	...	68,082	1904-05 to 1918-19.	
...	...	...	...	68,082	...	...	...	...	...	68,082	...	
.	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	442,649	...	...	21,198	...	...	463,847	1903-04 to 1915-16.	
...	...	...	...	442,649	...	...	21,198	...	...	463,847	...	
...	...	...	...	...	...	...	6,549	38,057	...	44,606	1895-96 to 1924-25.	
...	...	...	...	...	...	...	6,549	38,057	...	44,606	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	37,439	...	...	35,050	...	...	72,489	1905-06 to 1919-20.	
...	...	...	...	37,439	...	...	35,050	...	...	72,489	...	
...	...	...	...	...	...	...	..	750,080	1,690,942	2,441,022	1906-07 to 1909-10.	
...	...	...	...	...	...	...	...	750,080	1,690,942	2,441,022	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	

Name of Province.	Name of Conservator's Circle.	FOREST DIVISION.					DETAILS OF			
		Name of Forest Division.	Class of Forest.	AREA IN ACRES.						
				Under Working Plans.	Without Working Plans.	Total Forest area of Division.	Name of Working Plans relating to each Forest Division.	Principal species dealt with.	Number of Working Circle.	Number of Felling Series.
									BENGAL	
Bengal—*concld.*	Bengal—*concld.*	Chaibassa	Protected	...	126,801	126,801	...	......	...	...
		Total	...	...	126,801	126,801	...	......	...	...
		GRAND TOTAL	...	3,256,393	1,241,986	4,498,379	...	......	...	...
								EASTERN BENGAL		
Eastern Bengal and Assam.	Eastern Bengal and Assam.	Chittagong	Reserved Other reserves. Unclassed.	... ...	1,262,273 3,008 2,390,700	1,262,273 3,008 2,390,700	......	......	...	...
		Total	...	...	3,655,981	3,655,981	......	......	...	...
		Jalpaiguri	Reserved Other reserves. Protected	113,586	... 502 2,507	113,586 502 2,507	Reserved Forests of the Jalpaiguri Division.	Sal, etc.	5	19
		Total	...	113,586	3,009	116,595	......	......	...	...
		Buxa	Reserved Unclassed	208,865 ...	... 315	208,865 315	Buxa Forest Division.	...	5	6
		Total	...	208,865	315	209,180	......	......	...	...
		Cachar	Reserved Unclassed.	... ...	393,203 1,219,021	393,203 1,219,021	......	......	...	...
		Total	...	...	1,612,224	1,612,224	......	......	...	...
		Sylhet	Reserved Unclassed.	... ...	65,920 99,964	65,920 99,964	......	......	...	...
		Total	...	...	165,884	165,884	......	......	..	...
		Khasi and Jaintia Hills.	Reserved Unclassed	... ...	32,967 63,745	32,967 63,745	......	......	...	..
		Total	...	...	96,722	96,722	......	......	...	...
		Lushai Hills	Reserved	...	133,760	133,760	......	......	...	...
		Total	...	...	133,760	133,760	......	......	...	...

WORKING PLANS.

Area in acres under different Sylvicultural Systems.											Period of each Working Plan.	Remarks.
Method of Clear Fellings by Compartments with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method of Successive Regeneration Fellings.	Group Method.	Selection Method.	Storeyed Forest Method.	Simple Coppice Method.	Coppice with Standards Method.	Method of Improvement Fellings.	Area under Unregulated Fellings or Unworked.	Grand Total.		
—concld.												
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	24,736	...	677,526	...	...	75,052	788,137	1,690,942	3,256,393	...	
AND ASSAM.												
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	64,380	49,206	...	113,586	1904-05 to 1923-24.	
...	...	...	...	...	...	...	64,380	49,206	...	113,586	...	
...	...	...	...	208,865	...	...	...	...	...	208,865	1905-06 to 1919-20.	
...	...	...	...	208,865	...	...	...	...	..	208,865	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	

Name of Province.	Name of Conservator's Circle.	FOREST DIVISION.					DETAILS OF			
				AREA IN ACRES.						
		Name of Forest Division.	Class of Forest.	Under Working Plans.	Without Working Plans.	Total Forest area of Division.	Name of Working Plans relating to each Forest Division.	Principal species dealt with.	Number of Working Circles.	Number of Felling Series.
Eastern Bengal and Assam—*concld.*	Eastern Bengal and Assam—*concld.*							EASTERN BENGAL		
		Goalpara	Reserved Unclassed	334,402 ...	169,190 217,373	503,592 217,373	Goalpara Sal Forests.	Sal	5	...
		Total	...	334,402	386,563	720,965	......	......	...	...
		Kamrup	Reserved Unclassed	... ...	167,238 1,367,079	167,238 1,367,079	......	.. ...	...	...
		Total	...	...	1,534,317	1,534,317	......	......	...	...
		Darrang	Reserved Unclassed	1,988 ...	212.786 1,305,070	214,774 1,305,070	Sal Forests of the Darrang Division.	Sal	1	...
		Total	...	1,988	1,517,856	1,519,844	......	......	...	...
		Nowgong	Reserved Unclassed	... ...	126,873 2,156,883	126,873 2,156,883	......	......	...	...
		Total	...	...	2,283,756	2,283,756	......	......	...	...
		Sibsagar	Reserved Unclassed	41,133 ...	616,544 1,894,966	657,677 1,894,966	Namber Reserved Forests.	......	1	...
		Total	...	41,133	2,511,510	2,552,643	......	......	...	...
		Lakhimpur	Reserved Unclassed	... ...	221,392 1,911,586	221,392 1,911,586	......	......	...	...
		Total	...	...	2,132,978	2,132,978	......	......	...	...
		Garo Hills	Reserved	6,812	83,084	89,896	Dambu Reserve	.. ...	1	...
			Unclassed	...	1,884,924	1,884,924	Darugiri Reserve	.. ...	1	...
		Total	...	6,812	1,968,008	1,974,820	......	......	...	...
		GRAND TOTAL	...	706,786	18,002,873	18,709,659	......	......	...	...

WORKING PLANS.

Area in acres under different Sylvicultural Systems.											Period of each Working Plan.	Remarks.
Method of Clear Fellings by Compartments with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method of Successive Regeneration Fellings.	Group Method.	Selection Method.	Storeyed Forest Method.	Simple Coppice Method.	Coppice with Standards Method.	Method of Improvement Fellings.	Area under Unregulated Fellings or Unworked.	Grand Total.		
AND ASSAM—*concld.*												
...	...	...	...	334,402	...	...	...	...	...	334,402	...	Plan under revision
...	...	...	...	334,402	...	...	...	...	...	334,402	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	1,988	...	1,988	1906-07 to 1911-16.	
...	...	...	...	...	...	...	...	1,988	...	1,988	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	41,133	...	...	...	...	...	41,133	1904-05 to 1911-12.	
...	...	...	...	41,133	...	...	...	...	...	41,133	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	4,364	...	...	...	...	...	4,364	1-4-1887 to 31-3-1902.	
...	...	...	...	2,448	...	...	...	...	...	2,448	1-4-1890 to 31-3-1905.	
...	...	...	...	6,812	...	...	...	...	...	6,812	...	
...	...	...	...	591,212	...	...	64,380	51,194	...	706,786	...	

Name of Province.	Name of Conservator's Circle.	FOREST DIVISION.						DETAILS OF		
		Name of Forest Division.	Class of Forest.	AREA IN ACRES.			Name of Working Plans relating to each Forest Division.	Principal species dealt with.	Number of Working Circles.	Number of Felling Series.
				Under Working Plans.	Without Working Plans.	Total Forest area of Division.				
Central Provinces.	Northern Circle.								CENTRAL	
		Mandla	A class	62,512	1,035,402	1,097,914	Bonjar Valley Forests.	......	1	...
			B class	...	546,075	546,075	Motinala Range Forests.	......	2	...
		Total	...	62,512	1,581,477	1,643,989	......	......	...	...
		Jubbulpore	A class	332,496	...	332,496	Jubbulpore Forest Division.	......	5	44
		Total	...	332,496	...	332,496	.....	......	...	...
		Damoh	A class	506,832	...	506,832	Damoh Forest Division.	......	4	...
		Total	...	506,832	...	506,832	......	......	...	...
		Saugor	A class	14,080	462,949	477,029	Saugor Forest Division.	......	6	27
			B class	...	6,302	6,302				
		Total	...	14,080	469,251	483,331	......	......	...	...
		Narsinghpur	A class	159,392	...	159,392	Narsinghpur Forest Division.	......	3	12
		Total	...	159,392	...	159,392	......	......	...	...
		Hoshangabad	A class	473,600	127,596	601,196	Hoshangabad Forest Division.	......	4	26
							Bori Range Forests	......	1	3
		Total	...	473,600	127,596	601,196	...	......	...	...
		Seoni	A class B class Unclassed	521,200	... 6,811 1,791	521,200 6,811 1,791	Korai Range Forests.	......	7	...
							Ganginala Range Forests.	......	6	...
							Ugli Range Forests.	......	7	...
							Chappara, Dhooma and Nerbudda Ranges.	......	9	17
		Total	...	521,200	8,602	529,802	......	......	...	...

WORKING PLANS.

Area in acres under different Sylvicultural Systems.												
Method of Clear Fellings by Compartments with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method of Successive Regeneration Fellings.	Group Method.	Selection Method.	Storeyed Forest Method.	Simple Coppice Method.	Coppice with Standards Method.	Method of Improvement Fellings.	Area under Unregulated Fellings or Unworked.	Grand Total.	Period of each Working Plan.	Remarks.
PROVINCES.												
...	...	...	...	15,971	...	...	...	...	46,541	62,512	1904 to 1935.	
...	...	...	...	...	...	...	...	...	...	...	1907-08 to 1937-38.	
...	...	...	...	15,971	...	...	...	...	46,541	62,512	...	
...	...	...	...	...	...	...	...	260,202	72,290	332,492	1899-1900 to 1928-29.	
...	...	...	...	...	...	...	...	260,202	72,290	332,492	...	
...	...	...	...	...	...	...	506,719	...	113	506,832	1899-1900 to 1928-29.	
...	...	...	...	...	...	...	506,719	...	113	506,832	...	
...	...	...	...	...	...	...	...	...	14,080	14,080	1903-04 to 1932-33.	
...	...	...	...	...	...	...	...	...	14,080	14,080	...	
...	...	...	...	...	...	...	23,884	...	135,508	159,392	1897 to 1917.	
...	...	...	...	...	...	...	23,884	...	135,508	159,392	...	
...	...	...	...	...	...	...	...	240,948	232,652	473,600	1897-98 to 1926-27.	
...	...	...	...	...	...	...	...	...	..	...	1897-98 to 1906-07.	
...	...	...	...	...	...	...	...	240,948	232,652	473,600	...	
...	...	...	...	...	...	...	...	100,740	20,616	121,356	1895-96 to 1924-25.	
21,523	...	...	...	...	...	...	6,116	31,006	22,836	81,481	1895-96 to 1924-25.	
...	...	...	...	...	...	...	...	33,105	52,288	85,393	1898-99 to 1927-28.	
...	...	...	..	...	...	...	...	144,054	88,916	232,970	1900-01 to 1929-30.	
21,523	...	...	...	...	...	...	6,116	308,905	184,656	521,200	...	

Name of Province.	Name of Conservator's Circle.	FOREST DIVISION.					DETAILS OF			
		Name of Forest Division.	Class of Forest.	AREA IN ACRES.			Name of Working Plans relating to each Forest Division.	Principal species dealt with.	Number of Working Circles.	Number of Felling Series.
				Under Working Plans.	Without Working Plans.	Total Forest area of Division.				
								CENTRAL		
Central Provinces—*contd.*	Northern Circle—*contd.*	Chhindwara	A class B class	426,798 ...	... 33,042	426,798 33,042	Siliwani Ghat Range Forests.	......	6	...
							Sank Range Forests	......	5	...
							Umreth Range Forests.	......	3	...
							Amarwara Range Forests.	......	4	...
							Ambara Range Forests.	......	4	4
		Total	...	426,798	33,042	459,840	.. ...	......	...	...
		GRAND TOTAL	...	2,496,906	2,219,968	4,716,874	......	......	...	...
	Southern Circle.	Balaghat	A class	554,240	72,738	626,978	Dhansua Range Forests.	...	9	...
							Sonawani Range Forests.	...	7	...
							Pandratola Reserve Forests.	...	1	...
							Baihar and Raigarh Range Forests.	...	1	2
							Paraswara Range Forests.	...	8	...
		Total	...	554,240	72,738	626,978	...	...	...	...
		Bhandara	A class B class	335,568 ...	... 5,497	335,568 5,497	Paoni Range Forests	...	4	...
							Bawan Thari Range Forests.	...	7	...
							Lakhni Range Forests.	...	3	...
							Gaikhuri Range Forests.	...	8	...
							Pertabgarh Range Forests.	...	6	...
		Total	...	335,568	5,497	341,065	...	...	...	...
		Bilaspur	A class	260,480	165,005	425,485	Chita Pandaria Range Forests.	...	1	...
							Lormi Range Forests.	...	3	...
		Total	...	260,480	165,005	425,485	...	...	...	...

WORKING PLANS.

Area in acres under different Sylvicultural Systems.												
Method of Clear Fellings by Compartments with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method of Successive Regeneration Fellings.	Group Method.	Selection Method.	Storeyed Forest Method.	Simple Coppice Method.	Coppice with Standards Method.	Method of Improvement Fellings.	Area under Unregulated Fellings or Unworked.	Grand Total.	Period of each Working Plan.	Remarks.
PROVINCES—*contd.*												
...	...	...	...	...	...	...	...	35,738	37,313	73,051	1895-96 to 1924-25.	
...	...	...	...	...	...	...	...	46,992	18,519	65,511	1896-97 to 1925-26.	
...	...	...	...	...	...	...	...	8,028	95,896	103,924	1896-97 to 1925-26.	
...	...	...	...	...	...	...	...	16,741	49,053	65,794	1896-97 to 1925-26.	
...	...	...	...	...	...	...	...	32,832	85,686	118,518	1901-02 to 1920-21.	
...	...	...	..	...	...	...	...	140,331	286,467	426,798	...	
21,523	...	...	...	15,971	...	...	536,719	950,386	972,307	2,496,906	...	
...	...	...	...	...	...	...	...	57,264	112,208	169,472	1896-97 to 1925-26.	
...	...	...	...	...	...	..	...	38,333	32,347	70,682	1896-97 to 1920-21.	
...	...	...	..	...	...	...	...	11,046	1,145	12,191	1896-97 to 1910-11.	
...	...	...	...	...	...	...	..	58,228	141,071	199,299	1906-07 to 1925-26.	
...	...	...	...	...	...	...	...	16,067	86,531	102,598	1899-1900 to 1928-29.	
...	...	...	...	...	...	...	...	180,938	373,302	554,240		
...	...	...	...	...	...	...	...	24,094	1,496	25,590	1893-94 to 1923-24.	
...	...	...	...	...	...	...	...	29,398	63,387	92,785	1893-94 to 1922-23.	
...	...	...	...	...	...	...	...	38,839	840	39,679	Do.	
...	...	...	...	...	...	...	...	40,488	52,615	93,103	1896-97 to 1925-26.	
...	...	...	...	...	...	...	25,240	...	59,171	84,411	1897-98 to 1926-27.	
...	...	...	...	...	...	...	25,240	132,819	177,509	335,568	...	
...	...	...	...	...	...	...	2,136	...	...	2,136	1895-96 to 1915-16.	
...	...	...	...	...	...	...	...	20,098	238,246	258,344	1898-99 to 1927-28.	
...	...	...	...	...	...	...	2,136	20,098	238,246	260,480	...	

Name of Province.	Name of Conservator's Circle.	FOREST DIVISION.					DETAILS OF			
		Name of Forest Division.	Class of Forest.	AREA IN ACRES.			Name of Working Plans relating to each Forest Division	Principal species dealt with.	Number of Working Circles.	Number of Felling Series.
				Under Working Plans.	Without Working Plans.	Total Forest area of Division.				
									CENTRAL	
Central Provinces—*contd.*	Southern Circle.—*concld.*	South Chanda	A class .	262,400	225,223	487,623	Ahiri Range Forests	...	2	...
			B I class .	...	219,288	219,288	Ghote Range .	...	1	11
			B II class .	...	332,100	332,100				
		Total .	...	262,400	776,611	1,039,011	...	...	...	...
		North Chanda	Reserved .	837,995	...	837,995	Salori and Ainsa Forests.	...	2	...
			B I class .	...	270,455	270,455	Warora Range Forests.	...	5	...
							Moharli Range Forests.	...	11	...
							Haveli Range Forests.	...	11	...
							Gungewahi Range Forests.	...	13	...
							Brahmapuri Range Forests.	...	11	...
							Wairagarh and Dhaba Range Forests.	...	2	...
		Total .	...	837,995	270,455	1,108,450	...	...	...	...
		Nagpur Wardha.	A class .	458,059	...	458,059	Arvi Range Forests	...	7	...
							Khondali Range Forests.	...	6	...
							East Pench Range Forests.	...	6	...
							West Pench Range Forests.	...	7	...
							Umrer Range Forests.	...	5	...
		Total .	...	458,059	...	458,059	...	...	...	...
		Raipur .	A class .	873,461	6,400	879,861	Billari Ghugwa Range Forests.	...	2	...
							Sirpur Khallari Range Forests.	...	6	...
							Dhantari Range Forests.	...	5	...
							Laun Range Forests	...	3	...
							Balod Range Forests.	...	5	...
							Sihawa Range Forests.	...	4	3
		Total .	...	873,461	6,400	879,861	...	...	...	...
		GRAND TOTAL .	...	3,582,203	1,296,706	4,878,909	...	...	...	...

WORKING PLANS.

Area in acres under different Sylvicultural Systems.												
Method of Clear Fellings by Compartments with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method of Successive Regeneration Fellings.	Group Method.	Selection Method.	Storeyed Forest Method.	Simple Coppice Method.	Coppice with Standards Method.	Method of Improvement Fellings.	Area under Unregulated Fellings or Unworked.	Grand Total.	Period of each Working Plan.	Remarks.
PROVINCES—*contd.*												
...	...	...	...	19,575	...	...	...	...	25,307	44,882	1896-97 to 1934-35	
...	...	...	...	...	...	...		45,244	172,274	217,518	1899-1900 to 1913-14.	
...	..	...	...	19,575	...	...	...	45,244	197,581	262,400	...	
...	...	...	...	...	...	...	12,559	...	...	12,559	1895 to 1924	
...	...	...	..	...	...	..	...	32,661	28,284	60,945	1898-99 to 1927-28.	
...	...	...	...	...	...	...	...	32,312	215,922	248,234	1896-97 to 1925-26.	
...	..	...	...	...	...	...	...	28,348	100,503	123,851	1897-98 to 1911-12.	
...	...	...	...	...	...	...	...	54,171	76,296	130,467	1896-97 to 1925-26.	
...	...	...	...	...	...	...	...	47,146	44,486	91,632	1895-96 to 1924-25.	
...	...	...	...	...	...	...	...	...	170,307	170,307	...	
...	...	...	...	..	...	...	12,559	180,638	635,798	837,995		
...	...	...	...	...	...	...	...	48,138	69,160	117,298	1895-96 to 1924-25.	
...	...	...	...	...	...	...	...	42,541	20,881	63,422	Do.	
...	...	...	...	...	...	...	...	69,914	73,583	143,497	1894-95 to 1932-33.	
...	...	...	...	...	...	..	...	37,484	37,850	75,334	1894-95 to 1923-24.	
...	...	...	..	...	...	...	...	41,700	16,808	58,508	Do.	
...	...	...		...	...	...	...	239,777	218,282	458,059		
...	...	...	...	...	...	...	1,200	...	406	1,606	1894-95 to 1913-14.	
...	...	...	...	...	...	...	...	25,412	75,229	1.0,641	1896-97 to 1925-26.	
...	...	...	...	...	...	...	55,178	...	57,795	112,973	1893-94 to 1922-23.	
...	...	...	...	...	...	...	10,420	.	141,255	151,675	1898-99 to 1927-28.	
...	...	...	...	...	...	...	45,767		51,120	96,887	1893-94 to 1922-23.	
...	...	...	...	...	...	...	12,809	56,014	340,856	409,679	1900 to 1930.	
...	...	...	...	..	...	...	125,374	81,426	666,661	873,461	...	
...	...	...	...	19,575	...	...	165,309	889,940	2.507,379	3,582,203	...	

Name of Province.	Name of Conservator's Circle.	FOREST DIVISION.					DETAILS OF			
		Name of Forest Division.	Class of Forest.	AREA IN ACRES.			Name of Working Plans relating to each Forest Division.	Principal species dealt with.	Number of Working Circles.	Number of Felling Series.
				Under Working Plans.	Without Working Plans.	Total Forest area of Division.				
									CENTRAL	
Central Provinces—*concld.*	Berar Circle.	Melghat .	...	449,540	89,809	962,821	Bairagarh-Gugumal Forests.	...	5	...
		Total .	...	449,540	89,809	962,821	...	...	...	...
		Amraoti . .	...	...	161,741	161,743	...	...	...	...
		Total .	...	...	161,741	161,743	...	...	..	...
		Buldana and Akola.	...	2,994	501,776	504,770	Loni-Bhongaon Forests.	...	2	...
		Total .	...	2,994	501,776	504,770	...	..	...	...
		Yeotmal . .	...	12,027	751,262	763,289	Penganga Reserve.	...	1	...
		Total .	...	12,027	751,262	763,289	...	...	...	...
		Betul .	...	755,684	90,672	846,356	Betul Forest Division.	...	7	24
		Total .	...	755,684	90,672	846,356	...	...	...	...
		Nimar . .	...	180,524	1,066,315	1,246,839	Kalibhit Working Circle.	...	1	4
		Total .	...	180,524	1,066,315	1,246,839	...	...	...	...
		GRAND TOTAL.	...	1,400,769	3,085,049	4,485,818	...	...	...	...
		GRAND TOTAL	...	7,479,878	6,601,723	14,081,601	...	...	...	...
									COO	
Coorg.	Coorg.	Coorg .	Reserved .	113,727	219,199	332,926	Devamachi-Mawkal Forests.	...	1	...
							Arkeri Reserved Forests.	...	1	...
							Anekadu-Attur Forests.	...	1	...
							Dubare Reserved Forests.	...	1	...
							Nalkeri-Hatgat Forests.	...	4	...
		Total .	...	113,727	219,199	332,926	...	...	...	...
		GRAND TOTAL.	...	113,727	219,199	332,926	...	...	...	...

WORKING PLANS.

AREA IN ACRES UNDER DIFFERENT SYLVICULTURAL SYSTEMS.												
Method of Clear Fellings by Compartments with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method of Successive Regeneration Fellings.	Group Method.	Selection Method.	Storeyed Forest Method.	Simple Coppice Method.	Coppice with Standards Method.	Method of Improvement Fellings	Area under Unregulated Fellings or Unworked	Grand Total.	Period of each Working Plan.	REMARKS.
PROVINCES—*concld.*												
...	...	...	...	...	...	...	...	297,576	151,964	449,540	1893-94 to 1907-08.	
...	...	...	...	...	...	...	...	297,576	151,964	449,540	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
2,994	...	...	...	...	...	...	...	...	...	2,994	1895-96 to 1909-10.	
2,994	...	...	...	...	...	...	...	...	...	2,994	...	
...	...	...	...	...	...	...	...	12,027	...	12,027	1893-94 to 1910-11.	
...	...	...	...	...	...	...	...	12,027	...	12,027	...	
...	...	...	...	...	...	...	...	407,024	348,660	755,684	1897-98 to 1926-27.	
...	...	...	...	...	...	...	...	407,024	348,660	755,684	...	
...	...	...	...	...	...	...	...	83,148	97,376	180,524	1897-98 to 1926-27.	
...	...	...	...	...	...	...	...	83,148	97,376	180,524	...	
2,994	...	...	...	...	...	...	...	799,775	598,000	1,400,769	...	
24,517	...	...	...	35,546	...	...	702,028	2,640,101	4,077,686	7,479,878	...	
RG.												
...	...	...	...	...	...	...	...	12,287	5,387	17,674	1899-1900 to 1909-10.	
...	...	...	...	...	...	...	...	18,262	...	18,262	1897-98 to 1911-12.	
...	...	...	...	12,877	...	...	...	...	...	12,877	1894-95 to 1903-09.	
...	...	...	...	...	...	..	...	11,363	...	11,363	1899-1900 to 1913-14.	
...	...	...	...	30,774	...	...	...	...	22,777	53,551	1886 to 1915.	
...	...	...	...	43,651	...	...	...	41,912	28,164	113,727	...	
...	...	...	...	43,651	...	...	...	41,912	28,164	113,727	...	

Name of Province.	Name of Conservator's Circle.	FOREST DIVISION.					DETAILS OF			
		Name of Forest Division.	Class of Forest	AREA IN ACRES.			Name of Working Plans relating to each Forest Division.	Principal species dealt with.	Number of Working Circles.	Number of Felling Series.
				Under Working Plans.	Without Working Plans.	Total Forest area of Division.				
									AJMER	
Ajmer-Merwara.	Ajmer-Merwara.	Ajmer	Reserved . Protected. Unclassed.	89,670 110 ...	1,009 5 3,471	90,678 115 3,471	Ajmer-Merwara Forests.	...	4	...
		Total .	...	89,780	4,485	94,265	...	...	...	...
		GRAND TOTAL	...	89,780	4,485	94,265	...	...	...	...
									BUR	
Burma (Lower).	Pegu Circle.	Theyetmyo .	Reserved . Unclassed .	84,204 1,142	285,276 1,845,221	369,480 1,846,363	East Yoma, Satsuwa and Tindaw Reserves.	...	1	...
		Total .	...	85,346	2,130,497	2,215,843	...	...	...	...
		Prome . .	Reserved .	208,080	401,771	609,851	Shwele Forests .	...	1	...
			Unclassed.	...	908,082	908,082	Nawin Forests .	...	3	...
		Total .	...	208,080	1,309,853	1,517,933	...	...	...	...
		Zigon . .					Kangyi Forests .	...	1	...
			Reserved .	256,878	23,680	280,558	Gamon Forests .	...	1	...
			Unclassed.	...	244,051	244,051	Bawbin-Minbu Forests.	...	1	...
							Taungnyo Forests.	...	1	...
		Total	...	256,878	267,731	524,609	...	...	...	...
		Tharrawaddy	Reserved . Unclassed.	200,326 ...	25,808 110,146	226,134 110,146	Thonze Reserve .	...	1	...
							Kadin Bilin Reserve	...	1	...
							Kon „ „	...	1	...
							Mokka „ „	...	1	...
							Minhla Reserve .	...	1	...
							Satpok, Sitkwin and Thindawyo Reserves.	.	3	...
		Total .	...	200,326	135,954	336,280	......	...	...	...

WORKING PLANS.

Area in acres under different Sylvicultural Systems.											Period of each Working Plan.	Remarks.
Method of Clear Fellings by Compartments with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method of successive Regeneration Fellings.	Group Method.	Selection Method.	Storeyed Forest Method.	Simple Coppice Method.	Coppice with Standards Method.	Method of Improvement Fellings.	Area under Unregulated Fellings or Unworked.	Grand Total.		
MERWARA.												
...	...	...	...	...	...	...	41,101	...	48,679	89,780	1896-97 to 1915-16.	
...	...	...	..	...	...	...	41,101	...	48,679	89,780	...	
...	...	...	...	...	...	...	41,101	...	48,679	89,780	...	
MA.												
...	...	...	...	85,346	...	...	...	...	...	85,346	1906-07 to 1937-38.	
...	...	...	...	85,346	...	...	...	...	...	85,346	...	
...	...	...	...	73,489	...	...	...	...	...	73,489	1892-93 to 1921-22.	
...	...	...	...	134,591	...	...	...	...	...	134,591	1893-94 to 1922-23.	
...			...	208,080	...	...	...	...	...	208,080	...	
..	...	...	...	4,896	...	...	...	...	...	4,896	1892-93 to 1921-22.	
...	...	...	...	61,773	...	...	..	...	...	61,773	1889-90 to 1923-24.	
...	...	...	...	83,331	...	...	...	...	...	83,331	1890-91 to 1919-20.	
...	...	...	...	106,878	..	...	...	...	...	106,878	1891-92 to 1920-21.	
...	...	...	...	256,878	...	...	...	...	...	256,878	...	
...	...	...	...	69,735	...	...	...	...	...	69,735	1885 to 1914	
...	...	...	...	51,192	...	...	...	...	...	51,192·2	1885-86 to 1914-15.	
...	...	...	...	15,988	...	...	...	...	...	15,988	1885-86 to 1914-15.	
...	...	...	...	24,668	..	...	...	...		24,668·2	1885-86 to 1914-15.	
...	...	...	...	25,453	...	...	...	...	...	25,453	1889 to 1923	
...	...	...	...	13,290	...	...	...	...	...	13,290	1904-05 to 1928	
...	...	...	...	200,326	...	...	...	...	...	200,326	...	

Name of Province.	Name of Conservator's Circle.	FOREST DIVISION.					DETAILS OF			
		Name of Forest Division.	Class of Forest.	AREA IN ACRES.			Name of Working Plans relating to each Forest Division.	Principal species dealt with.	Number of Working Circles.	Number of Felling Series.
				Under Working Plans.	Without Working Plans.	Total Forest area of Division.				
Burma (Lower)—*contd.*	Pegu Circle—*contd.*								BURMA—	
		Rangoon .	Reserved .	173,584	71,961	245,545	Rangoon Plains Forests.	......	1	...
			Unclassed .	...	156,626	156,626	Rangoon Hill Forests.	......	1	...
		Total .	...	173,584	228,587	402,171	......	......	...	...
		Pegu .	Reserved	146,271	634,078	780,349	South Zamayi Reserve.	......	1	...
			Unclassed .	...	161,091	161,091	......	......	...	...
		Total .	...	146,271	795,169	941,440	......	......	...	...
		Bassein .	Reserved .	...	932,271	932,271	......	......	...	...
			Unclassed .	...	1,927,680	1,927,680	......	......	...	...
		Total .	...	...	2,859,951	2,859,951	......	......	...	...
		Henzada .	Reserved .	...	580,846	580,846	......	......	...	...
			Unclassed .	...	154,560	154,560	......	......	...	...
		Total .	...	...	735,406	735,406	......	......	...	...
		Arakan .	Reserved .	...	...	...	......	......	...	...
			Unclassed .	...	10,788,842	10,788,842	......	......	...	...
		Total .	...	...	10,788,842	10,788,842	......	......	...	...
		GRAND TOTAL .	...	1,070,485	19,251,990	20,322,475	......	......	...	...
	Tenasserim Circle.	Taungoo .					Kabaung Reserve .	......	1	...
							Bondaung Reserve.	......	1	...
			Reserved .	759,720	148,321	908,041	West Swa, Sabyin and Lonyan Reserve.	......	1	...
							Kyaukmasin Reserve.	......	1	...
			Unclassed.	...	1,715,252	1,715,252	Gwethe Reserve .	......	1	...
							Saing Working Circle.	......	1	...
							Pyu Chaung and Pyu Kun Reserves.	......	1	...
		Total .	...	759,720	1,863,573	2,623,293	......	......	...	...

WORKING PLANS.

Area in acres under different Sylvicultural Systems.											Period of each Working Plan.	Remarks.
Method of Clear Fellings by Compartment with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method of Successive Regeneration Fellings.	Group Method.	Selection Method.	Storeyed Forest Method.	Simple Coppice Method.	Coppice with Standards Method.	Method of Improvement Fellings.	Area under Unregulated Fellings or Unworked.	Grand Total.		
contd.												
...	...	...	...	53,014	...	...	...	...	...	53,014	1905 to 1924	
...	...	...	...	120,570	...	...	...	...	...	120,570	1905 to 1935	
...	...	...	...	173,584	...	...	...	...	...	173,584	...	
... ...	... ...	... ...	... ...	146,271 ...	... ...	... ...	... ...	... ...	... ...	146,271 ...	1905 to 1935 ...	
...	...	...	...	146,271	...	...	...	...	...	146,271	...	
... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	
...	...	...	...	...	...	...	...	...	...	...	...	
... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	
...	...	...	...	...	...	...	...	...	...	...	...	
... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	... ...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	1,070,485	...	...	...	...	...	1,070,485	...	
...	...	...	...	188,934	...	...	...	...	...	188,934	1894-95 to 1923-24.	
..	...	...	...	23,757	...	...	...	...	...	23,757	Do.	
...	...	...	...	94,694	...	...	...	.	...	94,694	1897-98 to 1928-29.	
...	...	...	...	25,432	...	...	...	...	...	25,432	1898-99 to 1925-26.	
...	...	...	...	30,872	..	...	...	...	...	30,872	1899-1900 to 1926-29.	
...	...	...	...	108,384	...	...	...	...	...	108,384	Do.	
...	...	...	...	287,647	...	...	...	...	...	287,647	1892-93 to 1934-35	
...	...	...	...	759,720	...	...	...	...	...	759,720	...	

1 Name of Province.	Name of Conservator's Circle.	FOREST DIVISION.						DETAILS OF		
				AREA IN ACRES.						
		Name of Forest Division.	Class of Forest.	Under Working Plans.	Without Working Plans.	Total Forest area of Division.	Name of Working Plans relating to each Forest Division.	Principal species dealt with.	Number of Working Circles.	Number of Felling Series.
									BURMA	
Burma (Lower)—*concld.*	Tenasserim Circle—*concld.*	Shwegyin	Reserved	384,167	79,831	463,998	Tonkan Reserve	......	1	...
			Unclassed	...	1,866,100	1,866,100	Nyaunglebin Working Circle.	......	1	...
		Total	...	384,167	1,945,931	2,330,098	......	......	...	...
		West Salween	Reserved	...	227,887	227,887	......	......	...	...
			Unclassed	...	2,235,607	2,235,607	......	......	...	...
		Total	...	...	2,463,494	2,463,494	......	......	..	...
		Thaungyin	Reserved	...	348,714	348,714	......	......	...	...
			Unclassed	...	2,235,120	2,235,120	......	......	...	...
		Total	...	...	2,573,834	2,573,834	......	......	...	...
		Ataran	Reserved	...	476,142	476,142	......	......	...	...
			Unclassed	...	2,724,264	2,724,264	......	......	...	...
		Total	...	...	3,200,406	3,200,406	......	......	...	...
		South Tenasserim	Reserved	...	831,450	831,450	......	......	...	...
			Unclassed	...	6,138,438	6,138,438	......	......	...	...
		Total	...	...	6,969,888	6,969,888	......	......	...	...
		GRAND TOTAL	...	1,143,887	19,117,126	20,261,013	......	......	...	...
Burma (Upper.)	Northern Circle.	Upper Chindwin.	Reserved	...	958,096	958,096	......	......	...	...
			Unclassed	...	4,731,760	4,731,760	......	......	...	...
		Total	...	...	5,689,856	5,689,856	......	......	...	...
		Myittha	Reserved	...	478,064	478,064	......			
			Unclassed	...	616,080	616,080	......	......	...	...
		Total	...	...	1,094,144	1,094,144	......	......	...	...
		Lower Chindwin.	Reserved	...	497,958	497,958	......	......	...	..
			Unclassed	...	417,920	417,920	......	......	...	...
		Total	...	...	915,878	915,878	......	.....	...	...

WORKING PLANS.

Area in acres under different Sylvicultural Systems.												
Method of Clear Fellings by Compartments with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method of Successive Regeneration Fellings.	Group Method.	Selection Method.	Storeyed Forest Method.	Simple Coppice Method.	Coppice with Standards Method.	Method of Improvement Fellings.	Area under Unregulated Fellings or Unworked.	Grand Total.	Period of each Working Plan.	Remarks.
—*contd.*												
...	...	...	...	...	...	...	...	14,041	5,620	19,661	1906-07 to 1913-14.	
...	...	...	...	363,618	...	...	...	...	888	364,506	1906-07 to 1934-35.	
...	...	...	...	363,618	...	...	...	14,041	6,508	384,167	...	
...	...	...	...	..	..	...	.	...				
...	...	...	...	..	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	..	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
..	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	1,123,338	...	...	...	14,041	6,508	1,143,887	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	..	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	

Name of Province. Name of Conservator's Circle.	FOREST DIVISION.					DETAILS OF			
			AREA IN ACRES						
	Name of Forest Division.	Class of Forest.	Under Working Plans.	Without Working Plans.	Total Forest area of Division.	Name of Working Plans relating to each Forest Division.	Principal species dealt with.	Number of Working Circles.	Number of Felling Series.
								BURMA	
Burma (Upper)—*contd.* Northern Circle—*concld.*	Mu . .	Reserved .	...	738,302	738,302	...	...	...	...
		Unclassed .	...	1,475,520	1,475,520	...	...	...	...
	Total .	...	...	2,213,822	2,213,822	..	...	...	...
	Katha . .	Reserved .	24,320	351.386	375,706	Mohnyin Reserve .	...	1	...
		Unclassed .	...	1,401,138	1,401,138				
	Total .	...	24,320	1,752,524	1,776,844	...	...	...	...
	Bhamo . .	Reserved .	...	215,619	215,619	...	...	...	...
		Unclassed .	...	2,555,520	2,555,520	...	...	...	...
	Total .	...	...	2,771,139	2,771,139	...	...	...	...
	Myitkyina .	Reserved .	...	108,800	108,800	...	...	...	...
		Unclassed .	...	3,814,400	3,814,400	...	...	...	...
	Total .	...	...	3,923,200	3,923,200	...	...	...	...
	GRAND TOTAL	...	24,320	18,360,563	18,384,883	...	...	...	...
Southern Circle.	Ruby Mines .	Reserved .	158,938	671,462	830,400	Nanhan, Nanpaw and Subok Reserves.	...	1	...
		Unclassed	...	2,625,674	2,625,674	...	...	...	...
	Total .	...	158,938	3,297,136	3,456,074	...	...	...	...
	Mandalay .	Reserved .	269,616	724,329	993,945	Madaya Range .	...	1	...
		Unclassed .	...	5,936,546	5,936,546	Maymyo Fuel Reserve.	...	1	...
	Total .	...	269,616	6,660,875	6,930,491	...	...	...	...
	Yaw . .	Reserved .	...	561,065	561.065	...	...	...	...
		Unclassed	...	1,889,871	1,889,871	...	...	...	...
	Total .	...	...	2,450,936	2,450,936	...	...	...	...

WORKING PLANS.

Area in acres under different Sylvicultural Systems.												
Method of Clear-Fellings by Compartments with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method of Successive Regeneration Fellings.	Group Method.	Selection Method.	Storeyed Forest Method.	Simple Coppice Method.	Coppice with Standards Method.	Method of Improvement Fellings.	Area under Unregulated Fellings or Unworked.	Grand Total.	Period of each Working Plan.	Remarks
—*contd.*												
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	24,320	...	...	...	...	...	24,320	1895-96 to 1909-10.	
...	...	...	...	24,320	...	...	...	...	...	24,320		
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	24,320	...	...	...	...	...	24,320	...	
...	...	...	...	158,938	...	...		...	...	158,938	1905 to 1935.	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	158,938	...	...	...	...	...	158,938	...	
...	...	...	...	...	...	...	...	248,730	...	248,730	1907-08 to 1926-27.	
...	...	...	...	...	...	...	20,886	...	...	20,886	1908-09 to 1927-28.	
...	...	...	...	...	...		20,886	248,730	...	269,616	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	

		FOREST DIVISION.					DETAILS OF			
				AREA IN ACRES.						
Name of Province.	Name of Conservator's Circles.	Name of Forest Division.	Class of Forests.	Under Working Plans.	Without Working Plans.	Total Forest area of Division.	Name of Working Plans relating to each Forest Division.	Principal species dealt with.	Number of Working Circles.	Number of Felling Series.
									BURMA	
Burma (Upper)—*concld.*	Southern Circle—*concld.*	Minbu	Reserved .	255,239	485,171	740,410	Taungdwingyi Reserve.	......	3	...
			Unclassed .	...	840,366	840,366				
		Total .	...	255,239	1,325,537	1,580,776	...	......	...	...
		Pyinmana .	Reserved .	658,885	18,078	676,963	Yeni Reserve .	......	1	...
			Unclassed .	21,760	1,194,880	1.216,640	Minbyin Reserve .	......	1	...
							Yonbin Reserve .	......	1	...
							Sinthe Reserve .	......	1	...
							Ngalaik Reserve .	......	1	...
							Yanaungmyin, Kaing and Palwe Reserve.	......	1	...
							Taungnyo Forests .	......	1	...
							Pozaung daung Reserve.	......	1	...
							Ziyamg Mehaw Reserves.	......	1	...
		Total .	...	680,645	1,212,958	1,893,603	......	......	...	...
		Southern Shan States.	Reserved .	...	172,800	172,800	......	......	...	...
			Unclassed .	...	8,038,400	8,038,400	......	......	...	...
		Total .	..	...	8,211,200	8,211,200	...	......	...	...
		GRAND TOTAL (Southern Circle.)	...	1,364,438	23,158,642	24,523,080	......	.....	...	..
		GRAND TOTAL (Burma.)	...	3,603,130	79,888,321	83,491,451	......	......	...	...
Baluchistan.	...	...	Reserved .	...	179,469	179,469	......	......	...	...
		Total	...	...	179,469	179,469	......	......	...	..
Andamans.	...	...	Reserved	...	101,930	101,930	......	......	...	...
			Unclassed	...	1,148,149	1,148,149				
		Total .	...	...	1,250,079	1,250,079	......	......	...	...

WORKING PLANS.

—*concld.*

Area in acres under different Sylvicultural Systems.												
Method of Clear Fellings by Compartments with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method or Successive Regeneration Fellings.	Group Method.	Selection Method.	Storeyed Forest Method.	Simple Coppice Method.	Coppice with Standards Method.	Method of Improvement Fellings.	Area under Unregulated Fellings or Unworked.	Grand Total.	Period of each Working Plan.	Remarks.
...	...	..	...	...	...	...	...	255,239	...	255,239	1907-08 to 1926-27.	
...	...	...	...	...	...	...	...	255,239	...	255,239	...	
...	...	...	...	50,363	...	...	...	...	...	50,363	1897 to 1927.	
...	...	...	...	131,965	...	...	...	...	...	131,965	1899 to 1929.	
...	...	...	...	81,295	...	...	...	...	...	81,295	1900 to 1930.	
...	...	...	...	67,963	...	...	...	...	...	67,963	1902 to 1932.	
...	...	...	...	80,585	...	...	...	...	...	80,585	1902 to 1932.	
...	...	...	...	123,762	...	...	...	...	...	123,762	1903 to 1933.	
...	...	...	...	67,997	...	...	...	...	...	67,997	1903 to 1933.	
...	...	...	...	52,011	...	...	...	...	...	52,011	1903 to 1943.	
...	...	...	...	24,704	...	...	...	...	...	24,704	1903 to 1923.	
...	...	...	...	680,645	...	...	...	...	...	680,645	...	
...	...	...	...	...	...	...	...	...	...	..		
...	...	...	...	...	...	...	...	...	...	...		
...	...	...	...	...	...	...	...	..	...	...	...	
...	...	...	...	839,583	...	...	20,886	503,969	...	1,364,438	...	
...	..	...	...	3,057,726	...	...	20,886	518,010	6,508	3,603,130	...	
...	...	...	...	...	...	...	...		...	...		
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	..,	...	...		
...	...	...	...	...	...	...	...	...	...	...		

Name of Province.	Name of Conservator's Circle.	FOREST DIVISION.					DETAILS OF			
				AREA IN ACRES.						
		Name of Forest Division.	Class of Forest.	Under Working Plans.	Without Working Plans.	Total Forest area of Division.	Name of Working Plans relating to each Forest Division.	Principal species dealt with	Number of Working Circles.	Number of Felling Series.
								SUMMARY OF TOTALS		
N.-W. F. Provs.	...	Total .	...	151,279	...	151,279	......	......	...	...
Punjab.	...	Total .	...	2,568,376	3,280,524	5,848,900	......	......	...	...
United Provinces.	Western Circle.	...	...	1,237,807	47,194	*1,285,001	......	......	...	...
	Eastern Circle.	...	...	1,161,853	217,634	1,379,487	......	......	...	...
		Total .	...	2,399,660	264,828	2,664,488	......	......	...	...
Bengal.	...	Total .	...	3,256,393	1,241,986	4,498,379	......	.. ...	...	...
E. B. & Assam.	...	Total .	...	706,786	18,002,873	18,709,659	......	......	...	...
Central Provinces.	Northern Circle.	...	...	2,496,906	2,219,968	4,716,874	......	......	...	...
	Southern Circle.	...	...	3,582,203	1,296,706	4,878,909	......	......	...	...
	Berar Circle.	...	...	1,400,769	3,085,049	4,485,818	.....	......	...	...
		Total .	...	7,479,878	6,601,723	14,081,601	......	......	...	...

WORKING PLANS.

AREA IN ACRES UNDER DIFFERENT SYLVICULTURAL SYSTEMS.												
Method of Clear Fellings by Compartments with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method of Successive Regeneration Fellings.	Group Method.	Selection Method.	Storeyed Forest Method.	Simple coppice Method.	Coppice with Standards Method.	Method of Improvement Fellings.	Area under unregulated Fellings or Unworked.	Grand Total.	Period of each Working Plan.	REMARKS.
BY PROVINCES.												
...	...	...	...	114,412	...	...	29,118	7,749	...	151,279	...	
...	...	...	47,595	1,399,911	...	74,134	466,662	408,943	171,131	2,568,376	...	
...	...	87,966	879	274,980	...	7,348	55,695	522,060	288,879	1,237,807	...	* Includes 7,977 acres of Unclassed Forest in the Sewalik and Jaunsar Divisions.
...	...	...	...	419,070	...	...	162,130	232,295	348,258	1,161,853	...	
...	...	87,966	879	694,050	...	7,348	217,825	754,455	637,137	2,399,660	...	
...	...	24,736	...	677,526	...	...	75,052	788,137	1,690,942	3,256,393	...	
...	...	...	...	591,212	...	...	64,380	51,194	...	706,786	...	
21,523	...	...	...	15,971	...	...	536,719	950,386	972,307	2,496,906	...	
...	...	...	...	19,575	...	...	165,309	889,940	2,507,379	3,582,203	...	
2,994	...	...	...	...	...	...	...	799,775	598,000	1,400,769	...	
24,517	...	...	...	35,546	...	...	702,028	2,640,101	4,077,686	7,479,878	...	

SUMMARY OF TOTALS

Name of Province.	Name of Conservator's Circle.	FOREST DIVISION. Name of Forest Division.	Class of Forest.	Area in acres. Under Working Plans.	Without Working Plans.	Total Forest area of Division.	DETAILS OF Name of Working Plans relating to each Forest Division.	Principal species dealt with.	Number of Working Circles.	Number of Felling Series.
Coorg.	...	Total .	...	113,727	219,199	332,926	....	......	...	...
Ajmer-Merwara.	...	Total .	...	89,780	4,485	94,265	.....	......	...	...
Burma.	Pegu.	...	...	1,070,485	19,251,990	20,322,475	.....	......	...	...
	Tenasserim.	...	...	1,143,887	19,117,126	20,261,013	......	.....	...	...
	Northern Circle.	...	...	24,320	18,360,563	18,384,883	......	.....	.	...
	Southern Circle.	...	...	1,364,438	23,158,642	24,523,080	......	.....	...	...
		Total .	...	3,603,130	79,888,321	83,491,451	......	......	.	...
Baluchistan.	...	Total .	...	...	179,469	179,469	...	......	...	...
Andamans.	...	Total .	...	...	1,250,079	1,250,079	......	......	...	...
		GRAND TOTAL	...	20,369,009	110,933,497	131,302,506	......	......		...

WORKING PLANS.

Area in acres under different Sylvicultural Systems.												
Method of Clear Fellings by Compartments with Artificial Regeneration.	Method of Clear Fellings by Strips.	Uniform Method or Method of Successive Regeneration Fellings.	Group Method.	Selection Method.	Storeyed Forest Method.	Simple coppice Method	Coppice with Standards Method.	Method of Improvement Fellings.	Area under Unregulated Fellings or Unworked.	Grand Total.	Period of each Working Plan.	Remarks.
BY PROVINCES—*concld.*												
...	...	...	...	43,651	...	...	...	41,912	28,164	113,727	...	
...	...	...	...	...	...	...	41,101	...	48,679	89,780	...	
...	...	...	...	1,070,485	...	...	...	...	...	1,070,485	...	
...	...	...	...	1,123,338	...	...	...	14,041	6,508	1,143,887	...	
...	...	...	...	24,320	...	...	...	...	...	24,320	...	
...	...	...	...	839,583	...	...	20,886	503,969	...	1,364,438	...	
...	...	...	..	3,057,726	...	...	20,886	518,010	6,508	3,603,130	...	
...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	..	...	...	...	...	...	...	...	
24,517	...	11,702	48,474	6,614,034	...	81,482	1,617,052	5,210,501	6,660,247	20,369,009	...	

Table II.

COMPARATIVE STATEMENT OF PROGRESS MADE IN WORKING PLANS UP TO 31ST DECEMBER 1908.

Comparative statement of progress made in working plans up to 31st December 1908.

PROVINCE.		AREAS FOR WHICH WORKING PLANS HAVE BEEN COMPLETED AND SANCTIONED.		AREAS FOR WHICH WORKING PLANS ARE BEING COMPILED.		Area for which working plans have still to be taken in hand.	Total forest area.	REMARKS.
		At commencement of the year 1908.	During the year 1908.	At commencement of the year 1908.	Taken in hand during the year 1908.			
		Sq. M.	Sq. M.	Sq. M.	Sq. M.	Sq. M.	Sq. M.	
Bengal		5,068	...	295	...	1,645	7,028	
United Provinces.	Eastern Circle	1,815	...	...	34	306	2,155	
	Western Circle	1,857	78	...	...	73	2,008	
Punjab		4,013	...	362	...	4,764	9,139	
Burma	Pegu Circle	1,672	...	...	...	30,082	31,754	
	Tenasserim Circle	1,187	601	265	...	29,605	31,658	
	Northern Circle	38	...	716	276	27,697	28,727	
	Southern Circle	1,811	820	663	315	35,208	38,317	
Eastern Bengal and Assam		1,103	...	199	158	27,775	29,235	
Central Provinces.	Northern Circle	3,902	...	939	...	2,529	7,370	
	Southern Circle	5,510	57	...	...	2,026	7,623	
	Berar Circle	2,189	...	...	...	4,820	7,009	
Coorg		178	...	...	...	342	520	
North-West Frontier		185	51	...	...	...	236	
Ajmer		140	...	...	...	8	148	
Baluchistan		...	...	...	...	280	280	
Andamans		...	...	317	...	...	1,953	
TOTAL BENGAL		30,218	1,607	3,756	783	168,796	205,160	
Madras	Northern Circle	2,281	255	602	1,074	2,599	6,811	
	Central Circle	2,177	248	1,724	536	2,558	7,243	
	Southern Circle	2,167	101	593	6	2,686	5,553	
TOTAL		6,625	604	2,919	1,616	7,843	19,607	
Bombay	Northern Circle	1,787	2	64	...	707	2,560	
	Central Circle	2,280	52	414	96	2,264	5,106	
	Southern Circle	920	25	204	64	3,379	4,592	
	Sind Circle	1,032	...	...	...	73	1,105	
TOTAL		6,019	79	582	160	6,423	13,368	

Table III.

STATEMENT SHOWING AREAS BROUGHT UNDER THE CONTROL OF SANCTIONED WORKING PLANS UP TO 31ST DECEMBER 1908.

Areas brought under the control of sanctioned working plans up to 31st December 1908 in the provinces outside the Madras and Bombay Presidencies.

PROVINCE.	FOREST AREA IN SQUARE MILES.				Area for which working plans prepared and sanctioned up to 31st December 1908.	Proportion of forest area under sanctioned working plans.
	Reserved.	Protected.	Unclassed State.	Total.		
					Sq. M.	Per cent.
Bengal	4,235	2,793	...	7,028	5,083	72
United Provinces . .	4,091	30	42	4,163	3,750	90
Punjab	2,176	5,241	1,722	9.139	4,013	44
Burma	22,859	...	107,597	130,456	5,629	4
Eastern Bengal and Assam	6 556	4	22,675	29.235	1.103	4
Central Provinces including Berar.	21,999	...	3	22,002	11,688	53
Coorg	520	...	..	520	178	34
North-West Frontier .	236	...	...	236	236	100
Ajmer.	142	...	6	148	140	95
Baluchistan . . .	280	...	...	280	...	...
Andamans . . .	159	...	1,794	1,953	...	...
TOTAL .	63,253	8,068	133,839	205,160	31,825	15·5

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Forest Pamphlet No. 10.   Forest Economy Series No. 3

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BURMESE LEZA WOOD

(LAGERSTRŒMIA TOMENTOSA, Presl.)

BY

R. S. TROUP, F.C.H.,
Imperial Forest Economist to the Government of India

CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
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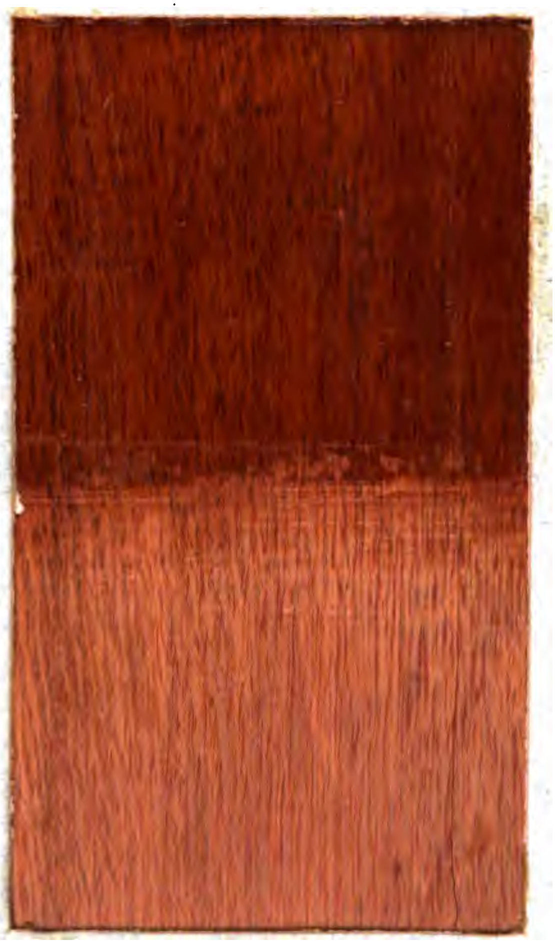
CARALLIA WOOD

(CARALLIA INTEGERRIMA, DC.)

BY

R. S. TROUP, F.C.H.,
Imperial Forest Economist to the Government of India

CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
1909



Carallia Integerrima, DC.

Syn. C. *lucida,* Roxb.

(No English Name.)

Chief Localities.—Sub-Himalayan tract, Eastern Bengal, Assam, Chittagong, Chota Nagpur, Orissa and the Circars, W. Ghats, Burma.

NOTE ON

CARALLIA WOOD.

Carallia integerrima, D. C.; Syn. *C. lucida,* Roxb., *C. ceylanica,* Wight. Natural order *Rhizophoreæ.*

1. Vernacular Names.

Maniawga, Burm.; *Awga,* Upper Burma; *Bya,* Arracan; *Kiabanj,* (Beng.) Chittagong; *Thekratenga, kujitekra, kujithakra, kujithakara, kanthekera, rata,* * Ass.; *Kujikaor,* Garo; *Kierpa,* Beng.; *Palamkat,* Nep.; *Jur,* ara mata, Kôl; *Shengali, panasi,* Mar.; *Andipunar, andipunai, andamargal, andamuria, andinaru,* Kan.; *Punschi, makadchirand,* Bombay; *Karalli,* Tel.; *Varanga, vallayam,* Mal.

2. Distribution and Habitat.

The tree is found in damp evergreen and swamp forests in the Sub-Himalayan tract, as far west as Dehra Dun, very scarce in the west, commoner in the east; Bengal (up to 4,000 ft. in Sikkim), Assam, Khasia Hills, Chittagong, Chota Nagpore, Orissa and the Circars, Western Ghats, Burma, chiefly in the moister parts of Pegu and Tenasserim.

The tree is typically found in moist or evergreen forests, often occurring along the banks of streams in shady localities. It is nowhere abundant, and in many localities is very rare. In the *Western Ghats* it occurs in evergreen or semi-evergreen forests and along streams ascending to about 2,500 ft. Mr. R. S. Pearson reports that it is found in small quantities all over the evergreen forests of Kanara, especially in Kumta and Ankola, up to 1,500 feet, the top of the Ghats. In Belgaum it is reported scarce. Mr. W. A. Talbot states that the tree is very scarce in the Central Circle, Bombay. In the *Madras Presidency* it is rare. In the South Kanara District Mr. B. H. Barlow-Poole reports it to be scattered all over the district except at the Ghats. In Ganjam it is reported to be so scarce as to be practically non-existent. Elsewhere it is either extremely rare or is not found at all.

---

* *Rata* is the name given to many species of trees with red wood, which have botanically nothing in common.

In *Bengal* the tree is found in several Forest Divisions, but is nowhere common. In *Eastern Bengal and Assam* it is found in the Kamrup, Cachar, Darrang, Nowgong, Sibsagar, Lakhimpur, Goalpara, Garo Hills and Chittagong Divisions. It occurs in damp localities and evergreen forests of the plains and lower hills up to about 2,000 feet. It is rare in most Divisions, but fairly common, according to Mr. E. M. Coventry, in Darrang. In Chittagong Mr. Heinig states that it is found in Cox's Bazar Sub-division and eastward into the hill tracts at 20—500 feet elevation, in mixed evergreen high forest, commencing from the high land behind the mangrove swamps. In Kamrup Division Mr. D. P. Copeland reports that it occurs on damp aspects at the foot of the Khasi Hills, especially on the lower hill slopes of the Myang Hill Reserve and Bardwar Reserve in evergreen forest up to an elevation of 500 feet. In the preliminary working-plan report for the Sal forests of Kamrup Division, on the south bank of the Brahmaputra, Mr. Copeland states that the tree forms part of the stock of evergreen forests and bamboos, in which Sal is absent; in these forests are to be found the sites of old *Jhums*, * which can be easily distinguished from the surrounding forest. The crop includes *Dendrocalamus Hamiltonii*, *Teinostachyum Dullooa*, *Mesua ferrea*, *Ficus elastica*, *Baccaurea sapida*, *Eriobotrya sp.*, *Licuala peltata*, *Macaranga spp.*, *Machilus spp.*, *Eugenia formosa*, *E. cymosa*, canes, etc. It is sometimes planted by the villagers in Assam for the sake of its fruit.

In *Burma* the tree is found in moist and evergreen forests, and on banks of streams, in Pegu and Tenasserim. In the lower mixed forests it is associated with *Dillenia pentagyna*, *Schleichera trijuga*, *Anogeissus acuminata*, *Lagerstrœmia Flos-Reginæ*, *L. tomentosa*, *Diospyros ehretioides*, *Albizzia odoratissima*, *A. procera*, *Careya arborea*, *Dipterocarpus alatus*, etc. Its distribution in Upper Burma, where Brandis states that it is found, has not been ascertained. The forest Divisions in which it is reported to occur are Pegu, Rangoon, Tharrawaddy (chiefly in the south of the district), Bassein (low-lying hills and plains forests on both sides of the Yomas), Thayetmyo (moist parts of the East Yoma, Satsuwa and Tindaw Reserves), Toungoo, Shwegyin, Thaungyin, W. Salween, Ataran, and South Tenasserim. Kurz, in his Preliminary Report, mentions that it is frequent in Pegu and Tenasserim up to 4,000 feet on metamorphic rocks, sandstone and permeable laterite, in evergreen tropical and upper mixed forests. Although locally common in suitable localities, it is nowhere very abundant.

---

* Shifting cultivation.

3. Description of Tree.

Carallia integerrima is a moderate sized to large handsome evergreen tree, with foliage of shiny thick elliptic leaves, and characteristically opposite branchlets. The bark is about ⅜" to ⅝" thick, the outer dead bark being corky and of a dark grey to pinkish colour, and the inner living bark pale greenish-yellow or pinkish when fresh-cut, turning orange-brown on exposure; on the inner surface of the cortex the ends of the numerous broad medullary rays are conspicuous as vertical streaks. These ends of the medullary rays are also very conspicuous as vertical streaks on the outer surface of the sapwood when the bark is stripped off. The tree often produces aërial roots, showing its connection with the mangroves. It produces coppice-shoots and root-suckers readily, and although it is sensitive to frost it has good powers of recovery. As a rule natural reproduction is reported to be good where the tree occurs, but possibly the reproduction may consist partly of root-suckers. Artificial reproduction by seed is carried out on a small scale in Assam by villagers, who cultivate the tree for the sake of its fruit. Mr. E. M. Coventry states that villagers in Darrang Division have successfully tried reproducing it by planting root-suckers.

In Burma the tree ordinarily grows to a height of 50—80 feet with a girth of 6 or 7 feet, and a clear bole of 40—50 feet. Logs of 50—60 cubic feet can be obtained. In Assam it is as large or nearly as large, but in Bombay and Madras it reaches a height of only about 40 feet, with a girth of 4 feet (exceptionally 6 feet) and a clear bole of 20 feet.

4. Description of Tree.

Grain, colour, etc.—*Sapwood* large, pink or light chestnut-brown, often with a yellow tinge. *Heartwood* red or chestnut-brown. The wood is hard and beautifully grained, the large medullary rays, when the wood is cut in a radial direction, producing a very handsome silver-grain like that of a good quartered oak, which the wood much resembles. The large pores are often filled with a resinous substance, this being particularly noticeable in the sapwood when the tree is freshly felled. The wood seasons well and does not warp, but is sometimes apt to crack, during seasoning, along the medullary rays. As it should always be cut in that direction, however, to show the silver-grain, this is not always a serious objection.

A sample sent to a furniture-manufacturer in India was much admired, and was reported to be very easy to work and well adapted for ornamental furniture.

Weight.—The weight per cubic foot of seasoned wood has been determined with regard to the following specimens :--

No. in Dehra Dun collection.	Whence received.	Weight in lbs. per cubic foot (seasoned wood).
308	Burma (1867)	47
743	S. Kanara (Cherry)	42
816	Burma (B. Ribbentrop) . . .	51
4489	Ré Nadi, Dehra Dun (J. S. Gamble) . .	48
4508		42
5284	Rangoon Division, Burma (A. Rodger) .	46
5291	Ré Nadi, Dehra Dun (R. S. Troup) . .	42
	Average .	45

These specimens all contain sapwood as well as heartwood. A cylinder of green wood cut in 1908 weighed 69·2 lbs. per cubic foot, and the sapwood and heartwood cut from the same log and weighed separately, scaled 68·6 and 73·5 lbs. per cubic foot respectively. After seasoning the above the pieces each weighed 42 lbs. per cubic foot. Specimen No. 5291 above was cut from this log.

Strength.—The following are the results of tests carried out by Professor W. C. Unwin in 1899 and Professor W. H. Everett in 1908, the former with Ceylon wood and the latter with Burmese wood from Rangoon Division:—

	Unwin.	Everett.
Resistance to shearing along the fibres (tons per sq. in.)	0·48	0·79
Crushing strength along the grain (tons per sq. in.)	2·670	4·07
Bending (transverse) strength (tons per sq. in.)	4·83	5·1
Stiffness, from bending tests, E, (tons per sq. in.)	561·3	565
Corresponding P *	601	634

Other values of P, from experiments, are 797 (Benson), 656 (Skinner), and 700 (Bourdillon).

Durability.—Carallia wood is said to be only fairly durable, and not to last well if exposed to the weather or in contract with the ground. For indoor work, however, it is quite suitable. Mr. R. S. Pearson reports that a log which had lain on the ground for two years in North Kanara was not found to be attacked by insects, and was still in a sound condition.

Herbert Stone's Description.—A sample of Carallia wood from Burma was sent to England in 1908 to Mr. Herbert Stone, who has kindly favoured me with the following report on it:—

"This is an attractive wood, strongly resembling European Oak in colour and figure. Few persons would be able to distinguish it from that wood when quartered. Unfortunately it is extremely brittle and hence unsuitable for many purposes, besides being very troublesome to work. Not that it is hard to work, on the contrary, it saws and planes easily; but the difficulty of planing to a level surface, through pieces ripping out, is great, and one can never tell when one's work is done. This applies to the radial section more particularly, as it is the 'silver-grain' which chips. In turning, the same difficulty is met with; the 'silver-grain' flakes off here and there. The specimen is of better quality in point of colour and figure than samples which I have seen from Ceylon and Queensland, but they all share the same defect of brittleness. It does not come up to expectation when polished, unless some colour be added, as the pale 'silver-grain' becomes invisible, except when viewed in certain directions, and the red pores, so effective in the freshly planed wood, assume a dull appearance. Having regard to its mechanical qualities, it is an inferior wood. As a furniture wood it cannot compete with European Wainscot Oak. I suspect its durability, Watt notwithstanding, and I cannot understand Beddome's statement that it is 'tough' and 'brittle' as it can scarcely be both."

---

* P, representing the transverse strength, is obtained from the formula $P = \frac{W \times L}{B \times D^2}$ where W is the breaking load, L the length of the bar between supports, in feet, and B and D, its breadth and depth in inches.

5. System of Working, and Outturn.

Carallia has not been specially worked in any of the localities in which it occurs, although it is cut in unregulated and selection fellings in common with other miscellaneous species. In South Kanara the tree is found in forest worked under coppice with standards, but it is not left as a standard. There has never been any regular market for the timber, the tree not being sufficiently plentiful. The chief source of future supply is Burma, where possibly some 500 logs could be obtained per annum, chiefly from the Toungoo, Tharrawaddy, Bassein, Rangoon, Pegu, Ataran and South Tenasserim Divisions. A limited supply could be obtained from the Darrang, Nowgong, Cachar and Lakhimpur Divisions of Assam, and possibly also from Chittagong, Kamrup, and Sibsagar Divisions. In Bombay and Madras the supply is extremely limited, though a small quantity might be obtained from North Kanara Division in Bombay.

6. Prices.

The following statement gives the duty rates and approximate prices of the wood in various localities:—

Locality.	Government duty.	Local market price.	Approximate rate at which the timber could be extracted.
Eastern Bengal and Assam.			
Kamrup Division	R2 per tree .	...	R1-4-0 per cubic foot, converted, at Gauhati.
Cachar "	...	10 annas per cubic foot in the round.	R1-6-0 per cubic foot, converted, at Silchar.
Darrang "	R2 per tree .	...	12 annas per cubic foot, at Tezpur steamer ghat.

Locality.	Government duty.	Local market price.	Approximate rate at which the timber could be extracted.
Eastern Bengal and Assam—contd.			
Nowgong Division	R2 per tree	...	
Sibsagar „	5 annas per tree	...	Not less than R1-8-0 per cubic foot, at Jamguri or Barpathar railway stations.
Lakhimpur „	6 annas per cubic foot.	...	R1-4-0 per cubic foot at Dibrugarh. R1-8-0 to R1-12-0 per cubic foot at Calcutta or Chittagong (converted timber).
Burma.			
Toungoo Division	...	R9 per log or ton.	(1) At Nyaungbintha R7 per log (about 18′×5′ girth). At Pyu R7 per log. At Oktwin R7-8-0 per log. In addition to the above cost there is a royalty of R1-8-0 per log of 4′ 6″ and over, and 12 annas per log 3′ to 4′ 6″ in girth. (2) Logs can be delivered at Rangoon (not f. o. b.) from Pyu at an extra cost of R4 per ton.
Ataran „	R1-8-0 per log 4′ 6″ and over, 12 annas per log 3′ to 4′ 6″.	...	...
Thaungyin „	Ditto	...	Extraction in the round to Moulmein is estimated to cost R9 per ton of 50 cubic feet.
South Tenasserim Division.	Ditto	...	...
Tharrawaddy Division.	Logs 4′ 6″ and over in girth, R1-8-0 each. Logs 3′ to 4′-6″ in girth 12 annas each.	R15 to R20 per ton in the round. R30 to R40 per ton, converted.	R30 per ton (converted) at Letpadan and Thonze railway stations.

Locality.	Government duty.	Local market price.	Approximate rate at which the timber could be extracted.
Burma—contd.			
Rangoon	Logs 4′ 6″ and over in girth, R1-8-0 each. Logs 3′ to 4′ 6″ in girth, 12 annas each.	...	...
Bassein	Ditto	R5 per log. R30 per ton, converted.	R5 per log, or R30 per ton, converted, at Bassein station or port.
Bombay.			
W. D. Kanara	R1-8-0 per khandy of 12½ cubic feet.	...	Extraction very difficult and costly. Chief supply from the 6 above-ghat villages round Muski.
N. D. Kanara	Ditto	...	R24 per ton of 50 cubic feet at Tavargatti, Southern Mahratta Railway. R28 per ton of 50 cubic feet at Kodibag (Karwar).
Madras.			
S. Canara	...	...	3 annas per cubic foot on the sea coast. Loading into country craft would be extra.

7. Uses of the Wood.

The wood is used for house-building (planking and house posts), furniture, rice-pounders (Burma), agricultural implements (Madras), and handles of spears and 'dahs' (Burma); it would be suitable for panelling, picture-frames, and other ornamental work if cut on a radial section to show the silver-grain. It has been tried and found very suitable for brush-backs.

Mr. B. H. Barlow-Poole says, with regard to the use of this wood in the Madras Presidency, that the people are afraid to use it owing to the superstition that it attracts fire, and that a building in the construction of which it has been used will one day catch fire; to obviate this they scorch it before use.

8. Minor Products.

The Burmese use the roots for medicinal purposes (F. J. Branthwaite), and the bark as medicine in dental and stomachic ailments. In Assam the fruit is eaten, and the pulp, dried in the sun, is used as a medicine in cases of dysentery and chronic malarial fever (D. P. Copeland and E. M. Coventry). In Bombay (Kanara) an oil is extracted from the seed and is mixed with or used as a substitute for ghee (G. E. Marjoribanks) and is also used on a small scale for lighting purposes (R. S. Pearson).

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PETWUN OR TRINCOMALI WOOD

(BERRYA AMMONILLA, Roxb.)

BY

R. S. TROUP, F.C.H.,
Imperial Forest Economist to the Government of India

CALCUTTA
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BURMESE IN WOOD

(DIPTEROCARPUS TUBERCULATUS, Roxb.)

BY

R. S. TROUP, F.C.H.,
Imperial Forest Economist to the Government of India

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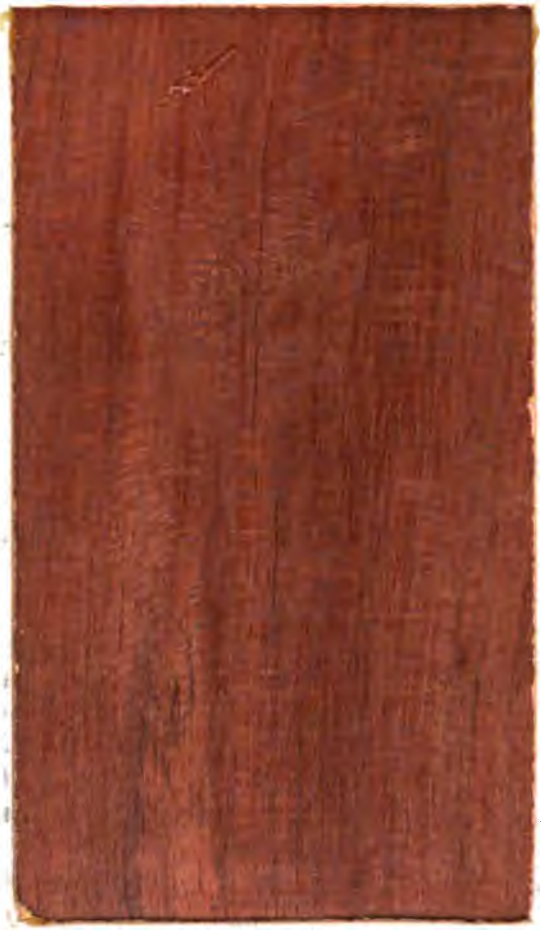
ADDENDUM.

Distribution of Dipterocarpus tuberculatus in Chittagong.

During 1909 a special search was made to ascertain the distribution of *Dipterocarpus tuberculatus* in Chittagong. The Divisional Forest Officer notes that specimens of *D. turbinatus*, *D. scaber*, *D. costatus*, *D. alatus* and *D. pilosus*, as identified by the Superintendent of the Royal Botanic Gardens, Calcutta, were received from Ranger officers in the Collectorate, but not *D. tuberculatus*. As *D. tuberculatus* is referred to in Prain's "Bengal Plants", Volume I, page 252, it will be searched for again in 1909-10. The Divisional Forest Officer remarks that the most probable locality of its occurrence is the mixed forest in the Chittagong Hill Tracts and Collectorate situated in the Cox's Bazar Subdivision south of the Matameri River and bordering on Arracan.

R. S. TROUP.

2nd October 1909.



Dipterocarpus tuberculatus, Roxb.

Syn. *D. Grandiflorus*, Wall.

Trade Name. *In* (Burmese):

Localities.—Burma Chittagong.

NOTE ON
BURMESE IN WOOD.

(DIPTEROCARPUS TUBERCULATUS, Roxb.)

IN.

(**Dipterocarpus tuberculatus**, Roxb. ; Syn. *D. grandiflorus*, Wall. Natural order *Dipterocarpeæ.*)

Vernacular.—*In* Burm. (sometimes written *eng* or *ein* by older writers) ; *Sooahn,* Talaing ; *Garjan,* Beng. (which is also the name given to other species of *Dipterocarpus*).

1. Distribution.

The *In* tree, which commonly occurs in a special type of forest known as *Indaing,* described below, is found throughout Burma, in suitable localities, up to about 2,500 feet altitude, and occasionally over, from the Myitkyina and Upper Chindwin Districts in the north to the Mergui District in the south. In the Southern Shan States it extends east of the Salween River and eastward into Cambodia. Its western limit is in Chittagong and Arakan. The map at the end of this publication shows the distribution of the tree in British territory as far as can be ascertained, but it probably extends over wider limits than are shown on the map.

The prevalence of the *In* tree in various localities is as follows :—

Chindwin, Mu, and Upper Irrawaddy.—Large tracts of *Indaing* forest exist between the Chindwin and Irrawaddy Rivers, covering a considerable portion of the Upper Chindwin, Myittha, Katha, Myitkyina, Bhamo and Mu Forest Divisions. This region contains the largest tracts of *Indaing* forest in Burma, these forests being scattered in greater or less extent over an area of some 20,000 square miles, and themselves aggregating several thousand square miles. To the west of the Chindwin River, *Indaing* forest is not abundant in the Upper Chindwin, but is commoner in the Myittha Division further south. Mr. L. C. Davis states that north of Homalin, in the Upper Chindwin, *In* is not plentiful.

Upper Irrawaddy, Eastern drainage.—East of the Upper Irrawaddy *Indaing* forest occurs fairly extensively in patches of varying size in the Myitkyina, Bhamo, Ruby Mines and Mandalay Divisions. In the Ruby Mines Division, as Mr. Walsh remarks, it forms a belt 5 to 10 miles broad on the left bank of the Irrawaddy and Shweli rivers, and occurs in rather extensive tracts on the right bank of the Shweli and in the drainage of the Kinchaung. In the north of the Mandalay Division there are fairly large tracts of *Indaing* on the Irrawaddy left bank and on the left bank of the Madaya River. In the *Pegu Yoma In* trees are frequently found occupying the tops of the drier ridges and spurs in small groups. *Indaing* forest is also found in greater or less extent flanking the outskirts of the teak forests of the Pegu Yoma both on the east and on the west side; this is seen in the Pyinmana, Toungoo, Minbu, Thayetmyo, Prome, Zigon, Tharrawaddy and Rangoon Divisions. These *Indaing* tracts sometimes extend a considerable distance into the Pegu Yoma, for example in the Pozaungdaung and Yeni reserves of the Pyinmana Division, containing 12 and 19 square miles of *Indaing* respectively, the Taungdwingyi forests of the Minbu Division, containing over 50 square miles of *Indaing*, and elsewhere.

Shan States.—*Indaing* forest occurs scattered over various parts of the Northern and Southern Shan States up to an elevation of about 2,500 feet.

East of the Sittang River.—A belt of *Indaing* runs almosts continuously down through the Pyinmana, Toungoo and Shwegyin Divisions, along the base of the hills forming the Sittang-Salween watershed.

West of the Irrawaddy.—Below Mandalay, *Indaing* forests occurs in stretches of varying size in the Yaw, Minbu, Thayetmyo, Prome and Henzada Divisions, ascending the Arakan Yomas to about 2,500 feet. It occurs in considerable extent between these Yomas and the Irrawaddy in the south of the Minbu District and the north of the Thayetmyo District.

In the *West Salween* Division, Mr. Lawrence mentions that *Indaing* forest is found up to 1,000 feet above sea-level scattered in more or less large tracts in most parts of the Thaton Sub-division. It is also frequent in the Thaungyin and Ataran forests, and is reported by Mr. F. Ryan to be found in many localities in the *Tavoy* and *Mergui* Districts.

In *Arakan* the *In* tree is reported to be found in Sandoway District on hill-sides up to about 1,200 feet in mixed evergreen forests.

In *Chittagong,* Mr. Heinig reports the tree to be found in Cox's Bazar Sub-division eastward, up to 500 feet, in mixed evergreen high forest.

2. Type of Forest.

The *In* tree as a rule occurs gregariously in a special type of forest known as *Indaing* where *In* is the most prevalent species, and is associated with *Ingyin (Pentacme suavis)*, *Thitya* (*Shorea obtusa*), *Thitsi* (*Melanorrhœa usitata*), *Lonbo* (*Buchanania latifolia*), *Taukkyan* (*Terminalia tomentosa* var. *macrocarpa*), *Te* (*Diospyros burmanica*), *Inchin* (*Aporosa macrophylla*), *Byu* (*Dillenia pulcherrima*) and other species. This *Indaing* forest varies much in quality. The best *Indaing* is as a rule found on flat or slightly undulating land, and in the great majority of cases the underlying rock is laterite. The *In* tree reaches a large size on deep, sandy loam or almost pure sand. *Indaing* occurs also on stiff clayey soils, but there *Terminalia tomentosa* (var. *macrocarpa,* a large leaved and large fruited variety) tends to become the predominating species. On hard ferruginous or lateritic ground with silicious pebbles the *Indaing* forest becomes very poor in quality and open. On dry hills and ridges the *Indaing* is also frequently of a stunted kind, and tends to develop into a type of forest containing little or no *In,* but much *Thitya* (*Shorea obtusa*) and *Ingyin* (*Pentacme suavis*). In the upper mixed teak forests of the Pegu Yoma and elsewhere *In* is often found occupying the tops of the ridges, accompanied in some cases by teak of small size. In the Myingyan District, on the flat and undulating land immediately to the east of Popa Mountain, there is a curious forest partly of pure *In,* and partly of *In* mixed with teak, on volcanic ash which was thrown out by Popa during the period when that ancient volcano was active.

The *Indaing* forests of the hill ranges extend into the region of pines (*Pinus Khasya* and *P. Merkusii*), but in these forests the *In* tree is often replaced by *Inbo* (*Dipterocarpus obtusifolius*).

In general appearance *Indaing* forest is often strikingly like Indian *Sal* forest.

In Chittagong and Arakan the habit of the *In* tree appears to differ from its usual habit in Burma, being found in mixed evergreen high forest. In the Nampaw Reserve of the Ruby Mines Division, Mr. Walsh notes a form of *Indaing* of rather moist type in which *In* is found mixed with *Kanyin* (*Dipterocarpus alatus*) on flat ground.

3. Density of Stock and Proportion of Size Classes.

In making enumerations of the growing stock for teak working-plans in Burma it has been the usual custom to discard *Indaing* forest as being unproductive of teak, and to make no enumerations in such forests. Hence, the quantity of *In* trees recorded as existing in the various teak working-plans as a rule gives no idea of the number actually existing, and since enumerations in *Indaing* forest have been carefully avoided in such working-plans, it is impossible with existing data to form a very accurate idea of the normal density of *Indaing* forest of various qualities.

The following figures, based on actual enumerations, give such information as is at present available :—

TABLE SHOWING RESULTS OF ENUMERATIONS MADE IN INDAING FOREST.

Table showing results of enumerations

No.	Forest Division.	Reserve and Locality.	Com-partment.	Area of sample plot.	NUMBER OF *In* TREES ENUMERATED.				
					7′ and over in girth.	6′–7′ girth.	4½′–6′ girth.	3′–4½′ girth.	Total 3′ girth and over.
1	Pyinmana	Pozaungdaung (Pegu Yoma).	36	43·6	119		166	322	607
2			37	52·2	113		185	276	574
3			...	97·5	366		359	642	1,367
4			...	55·5	133		319	540	992
5			44	107·7	397		536	694	1,627
6			...	125·2	65		419	1,475	1,959
7			...	91·8	56		405	1,384	1,845
8			45	134·2	547		508	767	1,822
9			...	121·6	108		521	1,934	2,563
10	Tharrawaddy	Satpók (plains)	19	178	106	64	158	418	746
11			21	178	86	103	146	264	599
12			22	177	144	149	214	446	953
13			23	177	88	147	254	326	815
14			25	178	293	126	146	657	1,222

made in Indaing Forest.

Number of *In* trees per 100 acres.					Remarks.	Author of Working-Plan.
7′ and over in girth.	6′–7′ girth.	4½′–6′ girth.	3′–4½′ girth.	Total 3′ girth and over.		
273		381	738	1,392	*Indaing* of variable quality.	Mr. G. E. S. Cubitt.
216		354	528	1,098	*Indaing* of good quality.	
375		368	658	1,401		
239		574	973	1,786		
368		497	644	1,509		
51		334	1,178	1,563		
61		441	1,507	2,009		
407		378	571	1,356	*Indaing* of variable quality.	
88		428	1,590	2,106		
...	...	...	...	...	Only part of the area *Indaing*.	Mr. R. S. Troup.
...	...	...	...	...	Chiefly *Indaing* of good quality but larger trees much cut out.	
...	...	...	...	...	Most of the area *Indaing*.	
...	...	...	...	...	About half the area *Indaing*.	
...	...	...	...	...	More than half the area *Indaing* of good quality.	

Table showing results of enumerations

No.	Forest Division.	Reserve and Locality.	Compartment.	Area of sample plot.	NUMBER OF *In* TREES ENUMERATED.				
					7′ and over in girth.	6′—7′ girth.	4½′—6′ girth.	3′—4½′ girth.	Total 3′ girth and over.
15	Tharrawaddy	Satpôk (Plains).	26	178	209	256	310	496	1,271
16			27	177	320	390	125	854	1,989
17			28	178	162	107	237	618	1,124
18	Pyinmana . .	Yanaungmyin (Pegu Yoma).	8	72·4	...	...	...	...	1,030
19	Do. . .	Minbyin (Pegu Yoma).	123	77·7	...	...	...	...	755
20	Toungoo . .	Gwethe (East of Sittang).	4	201·4	...	...	...	...	3,347
21			4	114·3	...	...	...	...	2,523
22			5	122·4	...	...	...	...	2,192
23			...	114·3	...	...	...	...	2,177
24			6	86·6	...	...	...	...	2,070
25			...	73·0	...	...	...	...	1,328
26			7	138·4	..	...	...	...	2,699
27			...	155·0	...	...	...	...	2,932
28			8	97·0	...	...	...	...	1,827
29			...	91·5	...	...	...	...	1,660
30			9	113·2	...	...	..	...	2,023
31			...	74·2	...	...	...	...	989
32			41	39·2	...	...	...	...	886

made in Indaing Forest.

NUMBER OF *In* TREES PER 100 ACRES.					REMARKS.	Author of Working-Plan.
7′ and over in girth.	6′–7′ girth.	4½′–6′ girth.	3′–4½′ girth.	Total 3′ girth and over.		
...	...	...	...	...	About half the area *Indaing* of good quality.	Mr. R. S. Troup.
180	220	240	482	1,122	Almost all *Indaing*.	
...	...	...	...	...	Only part of the area *Indaing* which is of good quality but has been much cut.	
...	...	...	...	1,422	......	Mr. C. W. Doveton.
...	...	...	...	972	Laterite and sand . . .	Mr. S. Carr.
...	...	...	...	1,661	These areas may be taken to be almost entirely *Indaing*, there being only small strips of teak forest along streams in some cases.	Mr. F. J. Branthwaite
...	...	...	...	2,207		
..	...	...	...	1,790		
...	...	...	...	1,904		
...	...	...	...	2,390		
...	...	...	...	1,819		
...	...	...	...	1,950		
...	...	...	...	1,891		
...	...	..	...	1,883		
...	...	...	...	1,814		
...	...	...	...	1,787		
...	...	...	...	1,333		
...	...	...	...	2,260		

Judging by the figures given above, it is probable that the whole of the Pozaungdaung enumerations (Nos. 1 to 9) were carried out in pure or nearly pure *Indaing* forest, and may be taken as representative of such forest. Of the Satpôk enumerations (Nos. 10 to 17) that of Compartment 27 (No. 16 on the list) gives a fairly correct idea of normal *Indaing* forest of good quality. The average of all the Pozaungdaung and Satpôk enumerations gives the following percentage of size-classes :—

Girth—

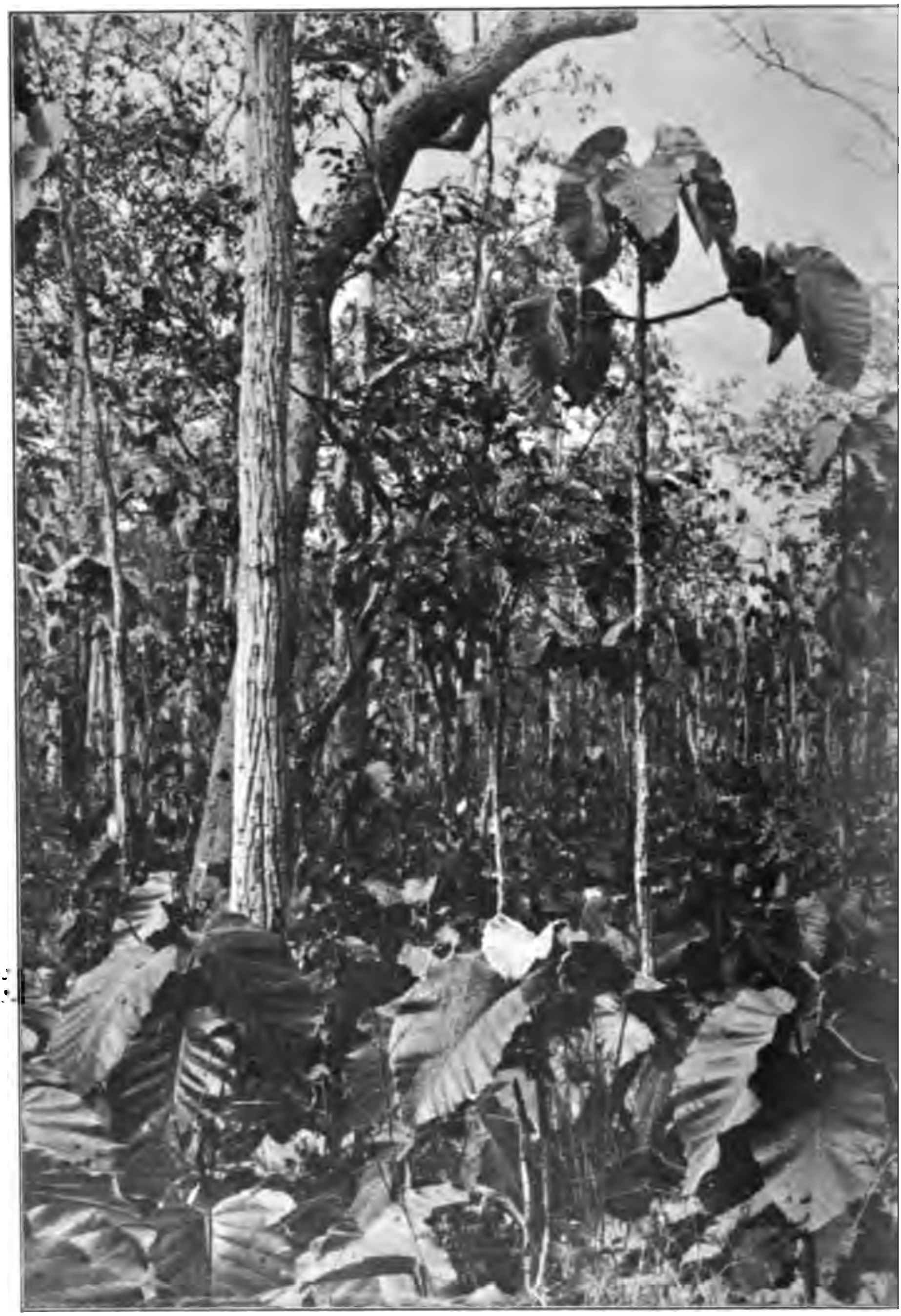
6 feet and over . .	19 per cent.	(In the Satpôk enumerations 51 per cent. of these are 7 feet and over in girth).
4½ to 6 feet . . .	25 per cent.	
3 to 4½ „ . . .	56 „	
	100	

Of the total number of *In* trees 3 feet in girth and over per 100 acres in *Indaing* forest all the Pozaungdaung enumerations, No. 16 of Satpôk, and those of Yanaungmyin, Minbyin and Gwethe (Nos. 18 to 32) probably give a fairly correct idea. The average of all these shows that natural *Indaing* forest normally contains about 17 *In* trees 3 feet in girth and over per acre, the most densely stocked of the above sample plots showing nearly 24 such trees per acre.

These figures demonstrate the characteristic gregariousness of the species.

4. Natural Reproduction.

Just as in Indian *Sál* forest, so in Burmese *Indaing* forest, the natural reproduction of the principal species is often profuse over large areas (*vide* Plate I), whereas in other cases there may be little or no reproduction at all, the ground being covered with coarse grass and little or no reproduction of *In* (*vide* Plate II). On hard barren pebbly laterite also reproduction is often poor. The natural reproduction of *Indaing* forest requires further study from a sylvicultural point of view, and whether or not fire protection will promote reproduction in areas where it is wanting, remains to be seen ; it is a fact, however, that *In* reproduction springs up in great abundance over large tracts of forest which are

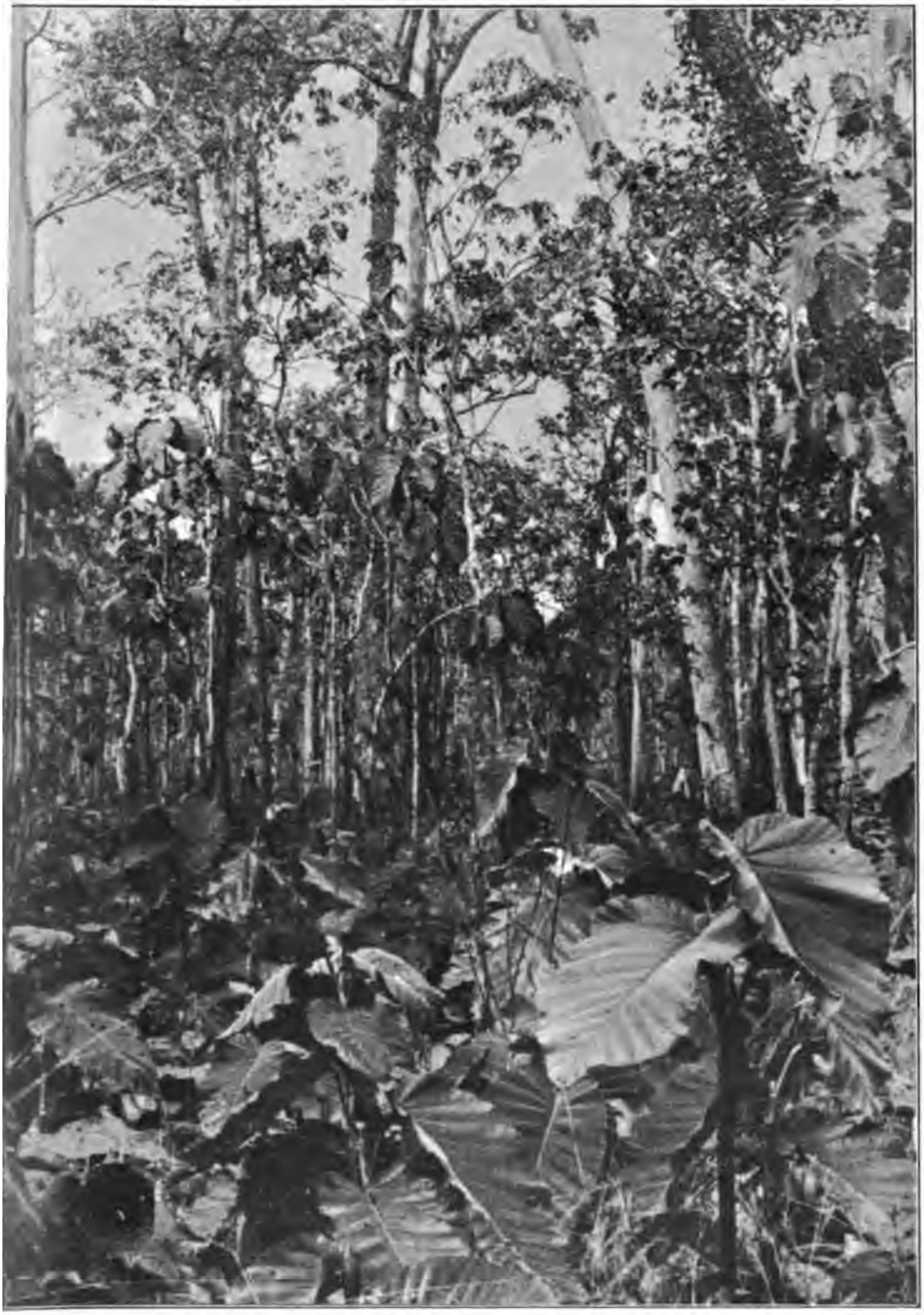


Half tone.

Natural Reproduction of *In (Dipterocarpus t*

Photo. by A. Rodger, I.F.S.

PLATE I.



Survey of India Offices, Calcutta, 19

culatus) in an area annually over-run by fire.

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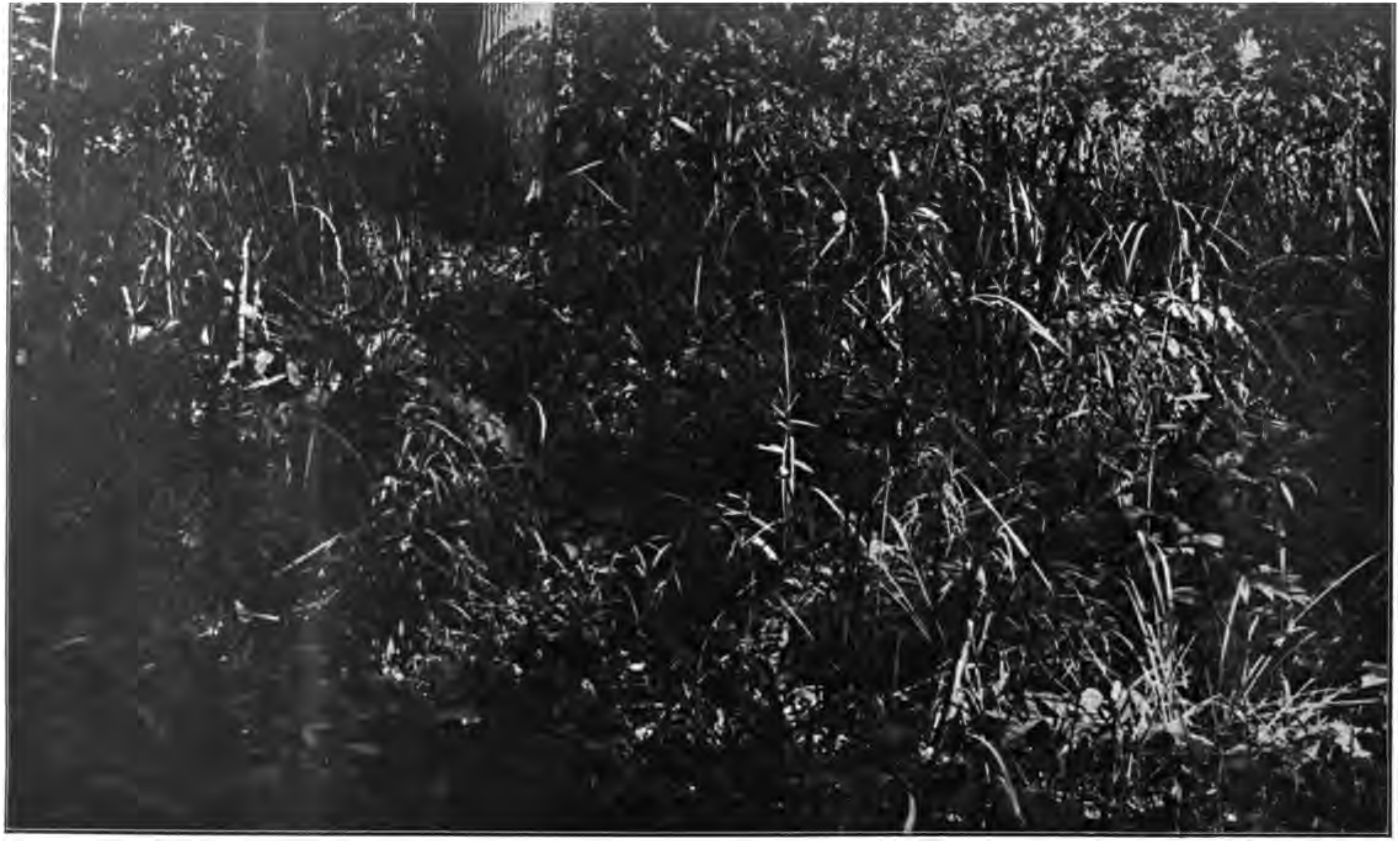
PLATE II.



Half-tone

Survey of India Offices, Calcutta, 1909

Large *In* trees *(Dipterocarpus tuberculatus)* with no reproduction, the ground being covered chiefly with coarse grass; area annually burned.

Photo. by R. S. Troup, I.F.S.

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annually overrun by fire. Heavy clearings in the over-wood result in dense masses of young growth springing up, in areas in a condition for natural reproduction.

5. Artificial Reproduction.

There has been little need hitherto for any attempts to reproduce *In* artificially, the natural forests being so extensive and the natural reproduction as a rule so good. In the Minbu Division of Upper Burma, an experiment was made in 1907-1908 to sow *In* and *Ingyin* (*Pentacme suavis*) in the Sabwet forest. The seeds germinated, but nearly all died for want of rain in June. Mr. Heinig states that he tried raising the tree artificially on a small scale in the Chittagong Division in 1888. He found that germination took place freely only when the seeds with the wings attached were placed sideways on the surface of the ground, no earth being placed over them.

6. Description of Tree.

The *In* is a large tree with a straight clean cylindrical bole and a rough longitudinally furrowed dark-grey or blackish bark about ½ an inch thick. In favourable localities it ordinarily grows to a height of 80 to 90 feet with a clear bole of 50 to 60 feet and a girth of 8 to 10 feet, but it may attain a height of over 120 feet and a girth of 15 feet.

On dry ridges and other unfavourable localities the tree becomes stunted and does not grow more than 30—40 feet in height.

The following measurements of large trees have been actually recorded :—

Height.	Clear bole.	Girth.	
100 feet . . .	...	15′	(F. J. Branthwaite, Toungoo).
120 " . . .	54′	12′	(").
... ...	85′5″	9′4″.	(C. B. Smales, Pyinmana). This tree yielded four logs.
130 " . . .	...	8′6″.	(R. M. Kavanagh, Shwebo).
130 " . . .	80′	9′9″.	(R. S. Troup, Katha).
... ...	75′	11′1″.	(").

The *In* tree loses its leaves, and puts out fresh foliage, in the hot season.

The rate of growth cannot be ascertained by ring-counting, but sample plots have been started with a view to obtaining statistics ; at present nothing is known regarding the rate of growth of *In*.

7. Size and Quality of Timber obtainable.

Logs of large size (up to about 60 feet length and 10 feet girth in favourable localities) could be obtained, but such logs could not ordinarily be extracted under existing means of transport.. Ordinarily *In* logs are cut into lengths of 18 to 25 feet to facilitate extraction.

In timber is exceptionally clean and cylindrical, and the wastage in conversion is therefore comparatively small. The wood when fresh felled is very resinous, the stumps of felled trees soon becoming thickly coated with exuded resin on the fresh cut surface. The resinous nature of the wood makes the hammer-marking of the timber troublesome, the design of the hammer becoming clogged up with resin; this can be prevented to some extent by frequently dipping the hammer in water.

The proportion of heartwood in an average sized log is ordinarily about 70 to 80 per cent.

"A point worthy of note", remarks Mr. C. V. Ryan, "is that large logs sell for less per ton than smaller logs. This appears somewhat paradoxical, but no doubt the cost of cart-hire in taking very large logs to the mills and the size of the saws used in Burman mills accounts for the disinclination to purchase logs of a very large girth. Added to this is the demand, which is not for large squares but for comparatively small scantlings."

8. Description and Properties of Wood.

Colour, Grain, etc.—*Sapwood,* grey to greyish-brown, about 1½″ to 2″ thick in moderate sized logs. *Heartwood,* dark reddish-brown (lighter when fresh cut), hard, straight-grained, with moderate sized to large pores, which are often filled with resin. The wood has a strong aromatic odour when fresh cut, and is extremely resinous, green logs exuding resin freely from their ends and from wounds, while sawn scantlings often exude resin until seasoned. The medullary rays are distinct and numerous, some moderately large and some small, giving a marked silver-grain on a radial section.

The wood works and polishes well and seasons quickly. If sawn up green, however, it is apt to warp, especially if sawn into thin boards. Seasoning in the log for some months prior to conversion would no doubt prevent this, but this is seldom done, though the timber often has a chance of becoming partially seasoned during transport in the log. The wood is easily sawn; in some cases, however, when it is sawn green it is said that the resin clogs the saw, and the sawyers pour water over the saw-cut at intervals to prevent this. I have never seen this done myself, and have heard no complaints of the kind at the saw mills, where large quantities of *In* timber are regularly converted.

Mr. Herbert Stone's Report.—A sample of *In* wood was sent to Mr. Herbert Stone of Birmingham in 1908, and he has kindly favoured me with the following report on it:—

> "This is a well known wood and is frequently met with in this country. I have the impression that it is sometimes passed off as Teak. I have not heard of its use as a furniture wood, and doubt whether it is likely to suit the English taste. It has been recommended as being suitable for paving blocks. If its character for durability is sufficiently good (the presence of wood oil in quantity sufficient to cause a freshly cut section to bleed, points in that direction), I think it should do well.
>
> "It has more resilience than the Australian Jarrah and Karri, and would afford firmer foothold for horses. It saws easily and freely, planes moderately hard, very evenly and well, being straight-grained. It is a good wood all round, and should find many uses for works of construction. It turns and polishes well, but when finished cannot be said to be beautiful, though by no means disagreeable to the eye."

Strength.—Professor Everett of Sibpur Engineering College in 1908 tested three samples of *In* wood received from the Pegu Circle, and obtained the following results:—

No.	Shearing strength along the grain (tons per sq. in.)	Crushing strength along the grain (tons per sq. in.)	Bending strength (tons per sq. in.)	Stiffness, from bending tests, E.	Corresponding P. *
1	0·69	3·18	5·7	525	709
2	0.56	3·07	4·9	640	610
3	0·69	2·65	5·2	500	647
Average . .	0·65	2·97	5·3	555	655
Average for teak† .	0·59	3·02	4·5	517	563

---

*$P. = \frac{W. \times L.}{B. \times D^2}$, where W is the breaking load in pounds, L the length of the bar between supports in feet, B and D its breadth and depth in inches.

†From Everett's "Memorandum on Mechanical Tests of some Indian Timbers", Forest ulletin No. 6, 1906.

Benson gives P=758, but he probably used pieces of smaller dimensions than those used by Everett.

The above figures show that *In* wood does not differ much from Teak as far as strength is concerned.

Durability.—*In* wood is only fairly durable, and is by no means proof against white ants and rot. Although largely used for house-building, it does not last long in contact with the ground, and is therefore not very suitable for house-posts. Planks and boarding exposed to the weather are usually smeared periodically with earth-oil, which prolongs their life considerably. In contact with water *In* wood is not particularly durable. Experiments are now in progress in Burma to ascertain if sleepers of Powellized *In* wood are likely to prove sufficiently durable, but it may be some time before any satisfactory conclusions are arrived at.

9. System of Working the Forests.

No regular sylvicultural system has yet been adopted for working *Indaing* forests. In reserved forests trees of a certain minimum girth, usually 6 feet, are marked for felling, and in unclassed forests the timber, if required for trade purposes, is felled and extracted under cover of licenses, the quantity and minimum girth being specified. It will thus be seen that in some respects the system of working may be termed "selection", but in unclassed forests there has been enormous waste of timber through lack of supervision over the fellings owing to the inadequacy of the forest staff. The common practice has been to fell trees and log them in a most wasteful manner, large quantities of utilizable timber being left to rot or burn in the forests. This is due to a large extent to the abundance of the timber, but it is having its effect on present supplies, for many of the most accessible *Indaing* forests of good quality have been depleted of large timber. Owing to the wonderful power of reproduction of the species, in many of these depleted forests large stores of young trees are coming up, but it is most advisable that all the good *Indaing* forests should be reserved and brought under proper management as soon as circumstances will permit.

The most rational system of working *Indaing* forest in areas where reproduction is good would appear to be the system of successive regeneration fellings (uniform method) owing to the readiness with which reproduction springs up where the over-wood is heavily opened out.

In timber for domestic purposes may be cut in unclassed forests without payment.

The actual working of *In* timber is, as a rule, easier than that of most kinds of timber, because the trees are gregarious and because *Indaing* forest is so frequently found on flat or slightly undulating country where carts can penetrate. *In* timber is almost invariably extracted in the log by dragging, carting, or floating and is converted, after extraction, at saw mills or by hand. In Arakan, however, it is sometimes converted in the forest.

In will not float unaided, and hence where water transport is employed the logs are rafted with the aid of bamboos, or are floated with the aid of boats, the logs being suspended from poles projecting several feet on either side.

Mr. R. M. Kavanagh furnishes the following note regarding *In* rafts on the Mu and Irrawaddy Rivers : " Trees are felled and timber logged into lengths varying from 18′ to 20′ and then carted to the Railway, or if on the Mu or Irrawaddy to the banks of the river, and floated down by means of bamboos (100 of which form a bundle). In a section there are 8 to 10 logs supported by 9 or 10 bundles of bamboos lashed together with *myaws* (poles), and in a raft there are generally 120 to 130 logs, which can be floated down in charge of 3 to 4 men."

Maung Kyi Myo, Forest Ranger at the Mandalay Timber Depôt, gives the following details regarding the rafting of *In* timber on the Upper Irrawaddy :—

> " Rafts made up at Tigyaing, Katha, Shwegu and Bhamo vary in the number of logs which they contain from 120 to 160 logs, but the usual number is 120. There are 12 to 14 sections in a raft, each section containing 10 to 12 logs. In rafts of *In* timber consisting of 10 to 12 logs a section, each section requires 1,200 bamboos, 5 poles and 220 canes, including requirements for the raftsmen's hut and for breakages on the way. An *In* raft carries a crew of 5 men, and the raft hire to Mandalay from different places is given below. The owner of the timber provides the raftsmen with food, the allowance being R1-8-0 per day in addition to the rafting charge.

"*Rafting Charges.*

	R
"(1) Bhamo	300
(2) Shwegu Moda Katha	250
(3) Tigyaing Shweli Mèza Tagaung	200

"*In* logs worked on floating streams like the Meza, Shweli, Moda, Shwegu, etc., are floated down these streams to their mouths at a cost of R4 to R6 per section of 10 to 12 logs.

"The price of bamboos (*tinwa*) is R2 to R2-8 per 100, canes R1 to R1-4 per 100, and poles R15 to R20 per 100.

"The cost of rafting for a raft of *In* containing 140 logs cubing 160 tons on the Irrawaddy River is as follow :—

	R	A.	P.
"(1) Raft hire from Shwegu to Mandalay	250	0	0
Food for crew	20	0	0
Making rafts at R3 per section (14 sections)	42	0	0
16,800 bamboos at R2 per cent. and eventually sold for R1 per 100 = R366	168	0	0
3,500 canes at R1 per 100	35	0	0
70 poles of unreserved woods at R15 per 100	10	8	0
1 Coir rope cost R90 is brought back from Mandalay 3 times a year. (It can be used 5 years)	6	0	0
2 Mooring canes at R3 each and eventually sold for R2 each	2	0	0
1 Canoe costs R8 to R15 and eventually sold for R3 to R7	3	0	0
100 bundles thatch at R1-8-0 per 100	1	8	0
5 Oars at R1-4-0 each, R6-4, and eventually sold for R3	3	0	0
TOTAL	541	0	0

that is, R3-13-9 per log, or R3-6-1 per ton."

10. Royalty Rates.

The Government royalty on *In* timber extracted by licensees in different localities is as follows :—

Northern Circle, Upper Burma.

	R	A.	P.	
Logs 4′ 6″ in girth and over	1	0	0	per log.
„ 3′ — 4′ 5″ in girth	0	8	0	„ „
Posts 1′ — 2′ 11″ in girth . . .	10	0	0	„ hundred.
„ under 1′ in girth	0	8	0	„ „

Southern Circle, Upper Burma.

In all Divisions except Yaw.					In Yaw Division.			
	R	A.	P.		R	A.	P.	
Logs 4′ 6″ in girth and over . .	2	0	0	per log.	1	0	0	per log.
Logs under 4′ 6″ in girth . .	1	0	0	„ „	0	8	0	„ „
Posts girth 1′—2′ 11″ . . .	0	8	0	each.	10	0	0	„ hundred.

Pegu Circle, Lower Burma.

	R	A.	P.	
Logs 4′ 6″ in girth and over	3	0	0	per log.
„ 3′—4′ 5″ in girth	2	0	0	„ „
Posts 1′—2′ 11″ in girth	0	8	0	each.

Tenasserim Circle, Lower Burma.

	R	A.	P.	
Logs 4′ 6″ in girth and over . . .	4	0	0	per ton. (R2 per ton in S. Tenasserim Division).
Logs 3′ —4′ 5″ in girth . . .	2	0	0	per log.
Posts 1′ —2′ 11″ in girth . . .	0	8	0	each.
Poles under 1 foot in girth . . .	1	0	0	per hundred.

Chittagong.

From unclassed State forests of the Hill Tracts, 10 per cent. *ad valorem*. From reserved forests of the Hill Tracts, 2 annas per cubic foot for green wood and one anna per cubic foot for dry wood.

11. Demand and Local Prices.

The demand for *In* timber is increasing, and the market prices show an upward tendency in most places. It is the commonest wood in the Mandalay market. Mr. W. H. Craddock remarks that better prices are obtained in the dry season than in the rains; this is probably due to the brisker demand for building timber in the dry season. It has been remarked above (page 12) that lower prices are usually obtained for very large logs than for those of moderate dimensions.

The prevalence of plague in Mandalay in 1906-1907 seriously affected trade in general, and the demand for *In* timber slackened, with a consequent fall of prices, but the market has recovered since then.

The local market prices of the timber at various centres are as follows:—

Locality.	Price.	
	Round timber.	Converted timber.
Upper Chindwin Division (Kindat)	About R5 per ton.	......
Myittha Division (Mingin)	R5 to R7 „ „	......
Mu Division (Shwebo)	R8 to R13 „ „	......
Mandalay Town	R8 to R11 per "atha" or about R9 to R12 per ton.	R28 per ton.
Pyinmana	Average R15 per ton.	......
Toungoo	R10 to R20 per ton.	......
Thayetmyo	R15 to R18 per ton.	......
Zigon and Tharrawaddy	R15 to R17 per ton.	R35 to R40 per ton.
Shwegyin	......	R55 per ton.
Moulmein	R12 to R25 per ton.	......
South Tenasserim	......	R40 per ton.

Locality.	Price.	
	Round timber.	Converted timber.
Rangoon	R15 to R20 per ton.	Scantlings 18′ × ½″ × 6″ R65 per ton. Scantings 18′ × 1″ × 6″ R50 per ton.
Arakan	……	R15 to R20 each for large planks of about ¼ to ½ a ton.
Chittagong	……	R0-14-0 to R2 per cubic foot.

12. Outturn.

Past outturn.—As *In* timber has usually been included with *Thitya* (*Shorea obtusa*) and *Ingyin* (*Pentacme suavis*) in the figures for outturn of forest produce, any statement of the quantity of *In* timber extracted for trade purposes can only be a very rough approximation to the actual facts. Further, as *In* timber may be cut in unclassed State forests in Burma for domestic use without any permit, the actual quantity cut during the past cannot possibly be estimated, but judging by the condition of many of the forests it must have been very large.

It is probable that at least 70,000 tons of *In* timber on an average have been extracted annually in Burma for trade purposes alone during the past five years, not including the large amount cut for domestic use. The great bulk of this came from unclassed State forests. During the past five years, some 400,000 logs, that is 80,000 logs per annum, arrived at Mandalay alone, and from that town about 18,000 logs and 8,600 tons of sawn timber have been exported annually to Lower Burma, much of this probably finding its way to Calcutta.

Future outturn.—The future outturn of *In* timber is quite impossible to estimate, as it will depend largely on the steps taken to reserve and protect *Indaing* forests and to bring such forests under systematic management; it will also depend to a great extent on the development of forest roads and other means of communication. Any estimate of the future possible outturn can therefore under present conditions be of the very roughest nature, and some Divisional Forest Officers have hesitated to form any estimate at all. The following rough estimates of future annual outturn have been furnished by certain Divisional Officers :—

Forest Division.	Estimated future annual outturn of *In* timber.	Remarks.
Upper Chindwin	At least 5,000 tons	All available for export except a very small quantity for local requirements.
Myittha	8,000 to 10,000 tons	
Mu	3,000 tons	1,500 tons available for export.
Katha	20,000 tons	All available for export.
Ruby Mines	12,000 tons	
Pyinmana	4,000 tons	Only 1,000 tons available for export.
Minbu, Thayetmyo	Quantity very small	......
Prome	2,000 tons	1,500 tons available for export.
Zigon	1,000 tons	About 750 tons available for export.
Toungoo	5,000 tons	All available for export.
Shwegyin	A large quantity. Estimate difficult to form.	......
Ataran	At least 5,000 logs (say 3,000 tons).	......
Thaungyin	Estimate difficult to form.	......
W. Salween	Small quantity, only sufficient for local requirements.	......
S. Tenasserim		
Arakan		
Chittagong		
Yaw	.. ...	Extraction too costly.

Forest Division.	Estimated future annual out-turn of *In* timber.	REMARKS.
Lower Chindwin . .	Not reported.	......
Bhamo		
Myitkyina . . .		
Mandalay . . .		
Bassein . . .		
Henzada . . .		
Pegu		

It is probable that the total annual quantity of *In* timber available for export for many years will be well over 50,000 tons.

13. Cost of Delivery.

The estimated cost, including duty, or delivery of *In* timber at various centres, is as follows :—

Place of delivery.	RATE OF DELIVERY.		Divisions from which obtained.	REMARKS.
	In the round.	Converted.		
Rangoon . . .	R10-8 to R12-8 per ton.	......	Toungoo . .	Not f. o. b.
	R17—18 per ton.	......	Prome, Myittha .	
	R20—23 " "	......	Zigon . . .	
	R27 " "	......	Mandalay, Pyinmana.	
	R30 " "	......	Katha . . .	
		R60 per ton.	Pyinmana . .	
		R70 " "	Shwegyin . .	
Mandalay . . .	R7—9 " "	......	Mu, Ruby Mines .	
	R15 " "	......	Katha . . .	By water.
	R30 " "	......	" . .	By rail.
Moulmein . . .	R15—23 " "	......	West Salween, Thaungyin and Ataran.	Not f. o. b.
Alon and Monywa .	R7—8 " "	......	Upper Chindwin and Myittha.	

Place of delivery.	RATE OF DELIVERY.		Divisions from which obtained.	REMARKS.
	In the round.	Converted.		
Yedashe . . .	R7-8-0 per ton	......	Toungoo . .	
Oktwin . . .	R8 ,, ,,	......		
Swa, Thagaya and Myohla.	R6 ,, ,,	......		
Thawatti and Shwemyo	R10—15 ,, ,,	R20—30 per ton.	Pyinmana . .	
Prome	R10 ,, ,,	......	Prome . . .	
Nattalin . . . Zigon . . . Gyobingauk . . Okpo	R10 ,, ,,	......	Zigon . . .	
Naba	R10 ,, ,,	......	Katha . . .	
Nyaunglebin . .	......	R55 per ton.	Shwegyin . .	
Shwegyin . . .	......	R50 ,, ,,		
Thaton . . . Kyaikto . . . Sittang . . . Hninpale . . .	R21 per ton.	R41 ,, ,,	West Salween .	
Duyinzeik . . . Zemathwe . . .	R16 ,, ,,	R36 ,, ,,		
Tavoy . . . Mergui . . .	......	R30 ,, ,, (squares)	......	f. o. b.
Singaung (seaport of Sandoway).	......	R45 ,, ,,	Arakan . .	
Silchar . . .	......	R1-6-0 per cubic foot.	Chittagong . .	

14. Uses of Wood.

In timber is largely used for house-building, chiefly for walling, flooring, rafters, and indoor work generally : it is not so suitable for boarding exposed to the weather, or for house posts, although sometimes used for these purposes. It is also used for boat-building, dug-out canoes, planks for bulwarks of paddy boats in Arakan, oars, helms, carts, axles, shafts, yokes, rough articles of furniture and joinery, boxes, and cooperage. Mr. R. E. Marsden mentions that it has been used by the

Burma Mines Development and Agency for pit-props in coal mining in the Chindwin, and gave satisfaction, more so than *Terminalia tomentosa*.

For purposes where great strength and durability are required the wood is not suitable, though it is probable that if antiseptically treated to increase its durability it will be suitable for purposes for which it is useless in its natural state. Thus for railway sleepers and paving blocks it is unsuitable in its natural state, but, as mentioned above, experiments are now in progress to test the suitability of railway sleepeers of *In* wood treated by the Powell wood-process and also with Jodelite preservative, and if the results of these tests are satisfactory there should be a large field for the utilization of the wood for railway sleepers and other purposes for which it is not used at present. *In* sleepers treated by Haskin's process have proved a failure, having lasted only about 5 years.

As regards *In* paving blocks authentic information has not been obtained. A few years ago they were reported to have been tried and found unsuitable, but the Chief Engineer to the Rangoon Municipality has recently informed me that they have never to his knowledge been tried in Rangoon. In any case it is very doubtful if the wood will be found durable enough unless first impregnated with some antiseptic.

15. Minor Products.

The tree yields a clear resin (*indwe*) used for caulking boats, and a dark thick oleo-resin used for torches. The latter is obtained by cutting a hollow in the side of the tree and applying fire; the oil exuding as a result of the heat collects in the hollow. The larger trees only are usually tapped. The leaves are used for thatching, packing, and plates. The seeds are eaten, and fetch about Rs. 3 a basket (F.J. Branthwaite).

16. Development of Trade.

There is room for considerable development of trade in *In* timber, particularly if the construction of roads and other communications in Burma is pushed on. With this end in view the reservation and protection of *Indaing* forest is a very necessary measure.

In order to encourage trade in this timber the Burma Government in 1898 addressed the leading timber firms in Burma offering concession for the extraction of *In* timber for *bonâ fide* export beyond India. These concessions were:—

(1) The grant of 5000 tons of *In* timber free of royalty during the first year.
(2) The grant of 10,000 tons at half royalty for the next five years.
(3) A guarantee that for a further period of 4 years the rates of royalty would not be enhanced.

This offer was renewed in 1906, but up to date it has not resulted in any extensive export trade in the wood, one reason given being that the freight charges on timber shipped to Europe swallow up all profits when the wood comes into competition with cheaper and lighter kinds.

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BURMA PADAUK

(PTEROCARPUS MACROCARPUS, Kurz.)

BY

R. S. TROUP, F.C.H.,
Imperial Forest Economist to the Government of India

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Pamphlet No. 9, Working Plan Series No. 3.—Tables showing the Progress made in Working Plans by Mr. A. M. F. Caccia, M.V.O., F.R.G.S., I.F.S., Imperial Superintendent of Forest Working Plans.

Pamphlet No. 10, Forest Economy Series No. 3.—Note on Burmese Leza Wood (Lagerstroemia tomentosa), by Mr. R. S. Troup, F.C.H., Imperial Forest Economist.

Pamphlet No. 11, Forest Economy Series No. 4.—Note on Carallia Wood (Carallia integerrima), by Mr. R. S. Troup, F.C.H., Imperial Forest Economist.

Pamphlet No. 12, Forest Economy Series No. 5.—Note on Petwun or Trincomali Wood (Berrya Ammonilla, Roxb.), by Mr. R. S. Troup, F.C.H., Imperial Forest Economist.

Pamphlet No. 13, Forest Economy Series No. 6.—Burmese In Wood (Dipterocarpus tuberculatus, Roxb.), by R. S. Troup, F.C.H., Imperial Forest Economist.

BURMA PADAUK

(PTEROCARPUS MACROCARPUS, Kurz.)

BY

R. S. TROUP, F.C.H.,
Imperial Forest Economist to the Government of India

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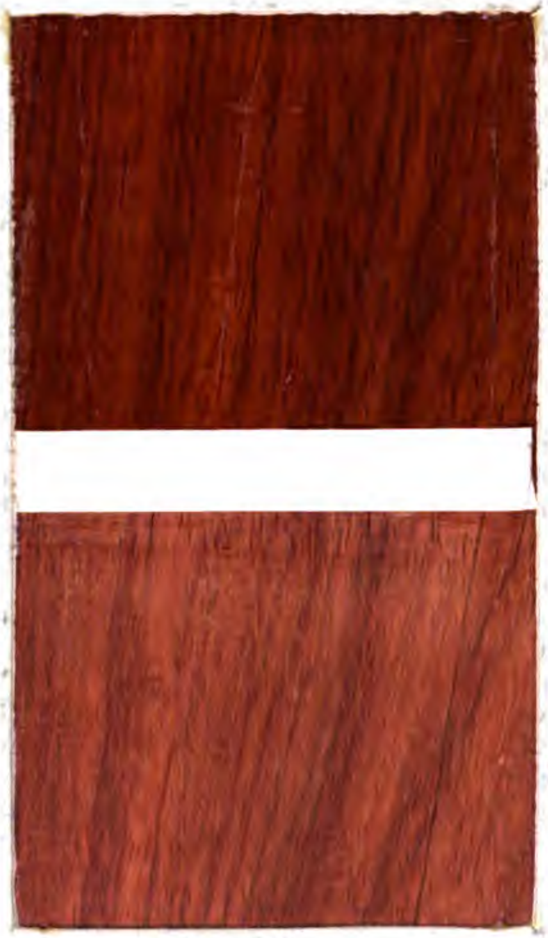

Pterocarpus Macrocarpus, Kurz.

(No Synonyms)

English Name—Burma Padauk.

Localities—Upper and Lower Burma.

BURMA PADAUK.

(PTEROCARPUS MACROCARPUS, Kurz.)

Natural Order—*Leguminosæ* (*Papilionaceæ*).

I. Nomenclature.

Considerable vagueness existed regarding the correct identfy of the species of tree yielding the timber known as Padauk until Prain undertook the examination of the genus *Pterocarpus* as represented in India, and published, in 1900, his "Report on the Indian Species of *Pterocarpus*". He has in this report set at rest certain misapprehensions regarding the origin of Padauk timber, and has established the fact that there are no fewer than three separate species of trees popularly known as "Padauk". These are as follows:—

(1) *Pterocarpus dalbergioides*, Roxb. Andaman Padauk, or Andaman Redwood. Found only in the Andaman Islands, and *not* in Burma.

(2) *Pterocarpus indicus*, Willd. This is the "Padauk" tree commonly planted along roadsides in Rangoon and other towns in Burma. As far as present evidence goes the tree is not indigenous in Burma, but has been introduced from the Malay Archipelago. In Burma, therefore, it is of no importance as a timber tree, being confined to gardens and roadsides.

(3) *Pterocarpus macrocarpus*, Kurz. This is the true forest "Padauk" tree of Burma and is the subject of the present pamphlet. It is found in Upper Burma, Tenasserim, and in the Prome and Thayetmyo Districts of Pegu; it is essentially a tree of the forests, and is undoubtedly the Padauk tree referred to by Brandis, Kurz and others in their writings descriptive of the Burma forests and referred to below.

This true Burma Padauk tree is not planted on roadsides or in gardens, and hence to the dweller in towns it is unknown, although it, and not the Andaman or the introduced Malayan Padauk trees, is the original *Padauk* of the Burman, the other two having been subsequently christened *Padauk* owing to family resemblance.

2. Vernacular Names.

The Burmese name of the tree is *Padauk*, but it also goes under the name of *Padauk-ni* (Red Padauk), *Padauk-pyu* (White Padauk), *Padauk-wa* (Yellow Padauk), *Padauk-sat* (Padauk of mixed colour), and *Padauk-nyo* (Brown Padauk). These are, as Prain has explained, all botanically identical.

It should be noted that the Burmese name Padauk is also given to *Pterocarpus dalbergioides*, Roxb. and *P. indicus*, Willd. A specimen marked *Padauk-po* (Male Padauk), from the Lower Chindwin has been named by Prain *Dalbergia obtusifolia** [this is *D. glauca*, Kurz. (*not of* Wall.)], and another specimen from the Tenasserim River marked *Pyin Padauk* was determined by him as belonging to the genus *Pahudia*.†

3. Distribution.

General Distribution.—The map accompanying this pamphlet shows in a general way the distribution of the Burma Padauk tree as far as our present knowledge goes. It is possible, however, that its range may be somewhat wider than is represented on the map, particularly in the hills bordering the Shan States and in those States themselves.

As far as we know at present the *Northern limit* is about the 24th parallel of latitude, in the Bhamo, Ruby Mines, Katha and Mu Forest Divisions. Possibly it may extend in the Chindwin drainage further north than is shown in the map, but it will require further investigation before this point is settled.

The *Southern limit* is in the South Tenasserim Forest Division, but the precise locality has not yet been determined. Prain notes authentic specimens from (1) Tavoy-Mergui Range (without precise locality), and (2) Palow Township, Tavoy.

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* Journal of the Asiatic Society of Bengal, Vol. 70, page 42.

† Indian Forester, Vol. XXVI, page 310.

The *Eastern limit*, so far as Burma is concerned, is the eastern boundary of Tenasserim and a locality in the Mongpan State of the Southern Shan States lying east of the Salween River and near the Siamese boundary. This locality, the precise name of which is not known, was marked on the map by Mr. Jenkins, Extra Assistant Conservator of Forests.

The *Western limit* is on the eastern slopes of the Arakan Yoma and the Chin Hills in Pakokku District.

Distribution in Special Localities.—As far as the distribution of the tree in various localities is concerned, the following information is available:—

Bhamo Forest Division.—Padauk is rare. Mr. G. E. S. Cubitt states that in the Bhamo subdivision it occurs at the upper end of the Sinkan Valley in small groups in open level country at an altitude of about 600 feet. Mr. P. E. Plunkett mentions that in the Shwegu subdivision it occurs only in the Setkala Reserve.

Katha Forest Division.—Mr. W. T. T. McHarg states that it occurs in limited quantity to the south of the Division.

Mu Forest Division.—Mr. R. M. Kavanagh reports that it is fairly abundant in the Kanbalu, Wuntho, and Kyunhla Ranges, at an altitude of about 800 to 1,000 feet. In the Kanbalu Range, which is very dry, the tree is of small size ; in the Wuntho and Kyunhla Ranges, which are moister, it attains larger dimensions.

In the *Chindwin drainage* Padauk occurs in the Myittha and Lower Chindwin Divisions, and has not hitherto been reported from the Upper Chindwin Division. In the Myittha Division Mr. D. H. Allan reports that it is found west of the Chindwin River in the Mingin and Maukkadaw Ranges, and a little occurs east of the Chindwin near Maukkadaw. It is, he says, nowhere very plentiful, being found in patches.

In the *Ruby Mines Division* Padauk is found, according to Mr. H. L. P. Walsh, throughout the Division at altitudes below 2,000 feet, and often attains a large size. The actual Padauk-bearing areas, however, are somewhat scattered.

In the *Mandalay Division* Padauk is found in the Madaya Forests, where it grows to a large size, and is sometimes very plentiful, as on the dry hills round Zagabin on the Madyaa river. It is found on the Shan Hills skirting the east of the Mandalay, Kyauksè and Meiktila Districts, in stunted form where the soil is very barren and the locality very dry, and of fair though not very large dimensions in the inner hills near Pyinyaung and Yebôksôn on the Thazi-Taunggyi road, where it is common.

In the *Yaw Division* Padauk is found on the hills to the west. One of Prain's identified specimens was collected at (or near) Baw Myo in the Chin Hills, and another at Gangaw.

In the *Minbu and Thayetmyo Divisions* Padauk occurs on the eastern slopes of the Arakan Yoma and the western slopes of the Pegu Yoma.

In the Thayetmyo Division Mr. C. H. Philipp reports that it is sparsely scattered over the Sinbaungwe and Kama Ranges, generally sparsely distributed in the Myede Range except in a few parts where it is numerous, and in the Minhla Range fairly numerous in the Myaukbet Circle, elsewhere scattered.

In the *Pegu Yoma* Padauk starts from the northern extremity of the range and occurs in varying quantity throughout the Pegu Yoma forests both on the Irrawaddy and on the Sittang side as far south as the Prome Division on the west and the Shwegyin Division on the east. It has never been found in the Zigon, Tharrawaddy, Rangoon and Pegu Divisions, while in the Pegu Yoma forests of the Shwegyin Division Mr. H. W. A. Watson notes having observed one solitary tree in the Nyaunglebin Working Circle. In the *Toungoo Division*, the southernmost limit of Padauk in any quantity in the Pegu Yoma forests may be said to be the Saing Working Circle, where the tree occurs in fair quantity. South of this it is rare, but it actually occurs in the Pyuchaung Reserve, near the south of the Division, where Mr. Watson notes that a solitary tree was observed in Compartment 10. It is reported as existing, but rare, in the West Swa, Sabyin and Lonyan Reserves, but is not reported in the Kabaung, Bondaung and Pyu-kun Reserves.

On the *Prome* side of the Pegu Yoma, Padauk reaches its southernmost limit in the South Nawin Reserve, where, however, only three Padauk trees have been observed.

In the Pegu Yoma, as far as is shown by enumerations hitherto carried out, Padauk is most numerous in the Sinthe Reserve, the most northerly and the driest of the Pyinmana reserves.

In *Tenasserim* Padauk has a fairly wide distribution, and it is probable that it extends further than is shown on the map.

Brandis, in his Report on the Attaran Forests, 1860, states that it is abundant in the Teak localities on the eastern feeders of the Sittang River, as well as in the Salween, Thaungyin and Attaran forests.

In the *Shwegyin* Division, east of the Sittang, Mr. H. S. Ker-Edie remarks that Padauk is found in the Kyaukkyi Range along the low-lying hills and surrounding dry deciduous forests.

In the *Thaungyin* Division it is reported to be not at all uncommon in the Thaungyin forests, being perhaps more plentiful in the Upper Thaungyin. West of the Dawna Range it is scarce. In the Myapadaing Circle there is a certain amount of it, but no regular survey of the forest has been made to ascertain how much there is.

In the *Ataran* Division it is stated to occur in small quantities in mixed deciduous forests and evergreen, on both plain and hill forests. This does not correspond with Brandis' statement that it is abundant in these forests, but it is possible that it may have been cut out to some extent since his time.

As regards the *Salween* drainage we have Brandis' statement that it was abundant there in 1860, but as far as can be ascertained at present, it is not very abundant, though fairly well distributed.

In *South Tenasserim* the tree has been recorded, and identified by Prain, from the Tavoy-Mergui Range and the Palaw Township. The Divisional Forest Officer notes that it is found in the northern portions of the Tavoy District, and that it is not plentiful.

4. Locality, Climate, Geology and Soil.

Locality and Climate.— The Padauk tree of Burma is usually found on undulating to hilly country up to 2,500 feet elevation. It occurs in localities with a rainfall of under 35″ to over 100″, but seems to thrive best with a rainfall of about 50″ to 100″.

The maximum and minimum temperatures recorded in areas where it is found are about 110° and 45°; it is probably found in localities with a lower minimum temperature, but is not known to occur in areas subject to frost.

Geology and soil.—Padauk is found on a variety of geological formations.

In the *Ruby Mines* Forest Division it is found on gneissic rock, and occasionally on limestone, soft sandstone and shale, the resulting soils varying from a deep rich red clay or clayey loam of lighter colour to a loamy sand; Padauk here grows to a large size (over 8 feet girth) only on the more sandy soils, especially in depressions between tracts of semi-*indaing** forest.

Such large-sized trees on sandy soil, however, are usually unsound ; well-drained loamy soil produces smaller timber, but the trees are sounder than those growing on very sandy soil.

In the Ziaing and Mehaw Reserves, east of the Sittang River in the *Pyinmana* Forest Division, Mr. F. H. Todd reports that the hills are very steep, and are formed of gneiss and porphyritic granite with laterite here and there ; the soil is a very sandy loam on the lower parts, capped with laterite, covered with *indaing* forest, on the top ; Padauk is found chiefly along the foot of the hills in the sandy loam, occurring in patches in rich teak forest. Further south, in the *Toungoo* Division, Padauk is found east of the Sittang in a coarse sandy loam on metamorphic rock of granitoid or schistose character in country which is more or less hilly, but not very steep.

In the *Pegu Yoma* Padauk is found on sandstone, sometimes with interbedded strata of shale and clay, and occasional tracts of laterite, up to about 1,000 feet elevation. The country is a mass of low hills and the Padauk chiefly occupies the upper and drier slopes, thriving particularly on sandy loam; it is absent in the moister valleys.

In the *Lower Chindwin* Division Padauk occurs in hilly country, the hills rising to 2,600 feet; the chief rock is sandstone and the soil usually a sandy loam. In the *Myittha* Division, further north, the tree is found in the Chindwin drainage from river level to about 2,000 feet elevation, in hilly country.

In the *Arakan Yoma* Padauk ascends the eastern slopes in the Minbu District, according to Mr. R. McIntosh, to about 2,000 feet. The rock is chiefly sandstone and shale.

5. Type of Forest.

The Padauk tree of Burma is found most typically in the drier types of upper mixed forest, being often found mixed with teak. It also occurs in *Indaing* forest, associated with *Pentacme suavis*, *Shorea obtusa*, *Dipterocarpus tuberculatus*, etc. It is to be found in stunted form in some of the poorer types of mixed forest in the dry zone of Upper Burma, along with *Tectona Hamiltoniana*, for example on the dry ghats where the railway from Mandalay to Maymyo ascends by zig-zags. The tree does not form pure forests, but is found scattered by single trees or in groups. In the *Bhamo* Division it grows at an elevation of about 600 feet in dry forest of a somewhat poor type, mixed with a poor class of teak, with *in (Dipterocarpus tuberculatus)*, *ingyin (Pentacme suavis)*, *kanyin (Dipterocarpus alatus)*, *taukkyan (Terminalia tomentosa)*, etc., and *tin* bamboo *(Cephalostachyum pergracile)*.

---

* Forest the characteristic trees in which are *In* (*Dipterocarpus tuberculatus*), *Thitya* (*Shorea obtusa*) and *Ingyin* (*Pentacme suavis*).

In the *Chindwin* drainage it is found in both *indaing* and ordinary mixed forest. In the *Mu* Division it occurs in fairly large quantities at altitudes varying from 800 to 1,000 feet, both in the dry zone in the Kanbalu Range (rainfall 33 inches) and in moister forest with a rainfall of 50 to 70 inches; in the former the trees do not attain a large size.

As regards the *Ruby Mines* Division, which perhaps contains the best Padauk forests in Burma, Mr. H. L. P. Walsh, Deputy Conservator of Forests, furnishes the following interesting note:—

> "The tree occurs throughout the district at altitudes below 2,000 feet: in exploitable size and abundance it is found:—
>
> (*a*) in the Irrawaddy drainage in dry mixed bamboo forest (*Dendrocalamus strictus*), which either forms a type of itself or intrudes along water-courses in the '*Indaing*' type in lateritic tracts. The important dry mixed bamboo forests occur as a belt running between the *Indaing* forest near the Irrawaddy river and the mixed teak forest which covers the hill slopes forming the Irrawaddy-Shweli watershed. The belt varies considerably in width, and is at an average altitude of 700 feet, and an average distance of 8 miles from the Irrawaddy. It is tapped by easily graded cold weather cart-roads, of a rough but sufficiently useful character.
>
> (*b*) In the Shweli drainage on the left bank 20 miles above the mouth of that river, in similar dry bamboo forest: but elsewhere in this drainage

> > the tree is a regular component of the moist mixed bamboo forest, being of best growth in the drier parts of the tinwa (*Cephalostachyum pergracile*) with thanatwa (*Bambusa Oliveri*) bamboo forests on somewhat lighter soils. In the moistest forests and on the stiffer clay-loam soils the tree, though found regularly, is not often found above 6 or 7 feet in girth, but is remarkably sound. The tree is most plentiful on all slopes at altitudes of 700 to 900 feet within 10 miles of the Shweli river. As a rule, in the Ruby Mines District, large growth denotes sandy soil and unsoundness in the timber: moderate growth denotes well drained loamy soil and sound timber: slender growth denotes a heavy and unsuitable soil.
>
> Nearly all the stock consisting of overmature trees, the effect of soils on the growth of the tree in its intermediate stages cannot easily be recognized ; it is possible that if felled before overmaturity the tree grown fast on a sandy soil is financially the best."

The late Mr. C. W. A. Bruce, in his Working Plan for Padauk in the Myadaung and Thabeitkyin Ranges of the Ruby Mines Division, says "the Padauk tree is found mixed with Myinwa (*Dendrocalamus strictus*) along water channels in the *indaing* and wherever the laterite soil gives way to richer soil. As the whole area is practically *indaing* bounded on the east by ordinary deciduous teak forest, the Padauk is very much scattered ; practically the area is *indaing* veined with Padauk and bamboo, while to the east the Padauk forms a narrow belt before the forest finally merges into teak forest."

In *Katha* Division the tree occurs sparsely on undulating or hilly ground. In the *Peya Yoma* Padauk is found in the drier types of upper mixed forest and also in *indaing* forest. In the upper mixed forests it is often found mixed with teak, the characteristic bamboos being *tin* (*Cephalostachyum pergracile*), *kyathaung* (*Bambusa polymorpha*), *myin* (*Dendrocalamus strictus*), *wapyu* or *wanwe* (*Oxyvenanthera albocilata*) and *thaik* (*Bambusa tulda*).

It is a striking fact that some of the working-plans sample-plots richest in Padauk are characterized by an abundant growth of the bamboo *Oxytenanthera albociliata*; this bamboo, as well as Padauk, appears to thrive well on a sandy soil.

Towards the northern extremity of the Pegu Yoma, where the forest becomes too dry for teak, for example in parts of the Sinthe Reserve in the Pyinmana Division, Padauk still persists, mixed with such dry-zone species as cutch (*Acacia Catechu*) and *dahat* (*Tectona Hamiltoniana*). In the very moist classes of Pegu Yoma forests the tree is entirely absent. In the Pegu Yoma a common state of affairs is to find teak mixed with Padauk on the upper parts of the ridges and spurs, and teak mixed with *pyinkado* (*Xylia dolabriformis*) on the lower and damper slopes and depressions.

In the *Mandalay* Division Padauk is associated in the Madaya drainage with teak and *thanawa* bamboo (*Thyrsostachys Oliveri*), and extends into drier forest where the characteristic bamboo is *Dendrocalamus strictus*. It is found in stunted form on the outer dry hills fringing the Mandalay plain. Further south, in the hilly country to the east of the Meiktila District and bordering on the Southern Shan States, it is found in rather dry forest.

In the *Shwegyin* Division Padauk is found sparsely scattered in dry deciduous forest along low hills east of the Sittang river. In the *Ataran* and *South Tenasserim* Divisions it is said to occur both in plains and in hill forests and to be found in evergreen as well as in deciduous forest ; this is contrary to its habit in Upper Burma.

6. Density of Stock.

The Padauk tree seldom if ever approaches gregariousness over any extent of area, and as compared with teak, *pyinkado*, and certain other well-known species, it forms as a rule but a very small proportion of the growing stock of the mixed forests in which it occurs. Working-plans figures are unfortunately not yet available for the forests of the Salween, Ataran, and Thaungyin drainages, or for the South Tenasserim Padauk areas, or for those of the Chindwin drainage, but in the two tables given below will be found the results of enumerations in some of the Padauk-bearing forests of Pyinmana, Toungoo, Thayetmyo, Prome, and the Ruby Mines. These figures show that in most of the reserves the number of sound Padauk trees of 3 feet girth and over varies from 20 to 30 per 100 acres, and that Padauk seldom forms more than 1½ per cent.

of the growing stock. Of the reserves hitherto enumerated the Sinthe reserve in the Pyinmana Division, consisting of dry mixed forest, contains a much greater proportion of Padauk than any other. By far the richest sample-plot yet enumerated, however, occurs in the Saing Working Circle of the Toungoo Division, which over an area of 47 acres contains over 10 Padauk trees, 3 feet in girth and over, to the acre. Strange to say, this abnormally rich sample-plot is situated not far from the southern limit of Padauk on the eastern slopes of the Pegu Yoma.

Brandis, in his Report on the Attaran Forests, 1860, states with regard to the forests of Tenasserim, "In some parts the prevailing trees in the forest are Padauk and Teak." Thus in the lower portion of the Kaymapjoo forest on the Upper Salween, there were found on an area of 0·36 square miles—

Teak trees in girth above 3 cubits	147
Padauk trees	317

The following table gives the results of enumerations of Padauk in connection with the preparation of working-plans for various reserved forests in Burma:—

ESTIMATE OF NUMBER OF PADAUK TREES PER 100 ACRES IN VARIOUS LOCALITIES.

Estimate of number of Padauk trees

Forest Division.	Name of Reserve.	ESTIMATED NUMBER OF SOUND PADAUK TREES 3′ AND OVER IN GIRTH OVER WHOLE RESERVE.		
		Total productive area of reserve in acres (*i.e.*, area for which stock has been estimated).	Total number estimated number of trees in reserve.	Estimated number of trees per 100 acres.
Pyinmana .	**Sinthe**	66,483	(*1*) 46,684	70
" .	Pozaungdaung . .	44,022	(*3*) 11,604	22
" .	**Taungnyo** . . .	64,729	(5) 14,418	21
" .	**Ngalaik**	77,583	(7) 19,000	24

per 100 acres in various localities.

NUMBER OF SOUND PADAUK TREES 3' AND OVER IN GIRTH ENUMERATED IN THE SAMPLE-PLOTS RICHEST IN PADAUK.			REMARKS.	Author of Working Plan.
Area of sample-plot in acres.	Total number of trees in sample-plot.	Number of trees per 100 acres.		
55·2	232	420	Near Northern extremity of Pegu Yoma. Situated within the dry zone. Rainfall about 45". Temperature 48° to 109° F. Forest much drier than in the other reserves of Pyinmana Division, and contains poorer teak and less *pyinkado*. Where padauk is most plentiful the prevailing bamboo is *myin*. (*1*) Of these about 500 are over 7' girth and 2,500 are 6'—7' in girth. (*2*) Of these 1 is over 7', 9 are 6'—7', and 184 are 3'—6' in girth.	Mr. F. Linnell.
52·4	(*2*) 194	370		
15·3	(*4*) 68	444	In Pegu Yoma. Padauk most abundant in dry mixed forest with *myinwa* as principal bamboo, and *kyathaungwa* and *thaikwa* next in abundance. (*3*) Of these 1,807 are 6' and over, and 9,797 are 3'—6' in girth. (*4*) Of these 16 are 6' and over, and 52 are 3'—6' in girth. Forest very dry: bamboos chiefly *myinwa*, with some *thaikwa* and *kyathaungwa*.	Mr. G. E. S. Cubitt.
53·9	(*6*) 115	213	In Pegu Yoma. Padauk nowhere very plentiful, but fairly evenly distributed over the area. Bamboos chiefly *myinwa* and *kyathaungwa*, with a certain amount of *tinwa* and *wanwè*. (*5*) Of these 1,744 are 6' and over, and 12,674 are 3'—6' in girth. (*6*) Of these 11 are 6' and over, and 104 are 3'—6' in girth.	Mr. C. W. Doveton.
(*8*) 100·5	84	83	In Pegu Yoma . . (*7*) Of these 4,000 are 6' and over, 7,000 are 4½'—6', and 8,000 are 3'—4½'. (*8*) Chief bamboos *kyathaungwa* and *tinwa*, with *myinwa* on ridges: rich in teak. (*9*) Chief bamboos *kyathaungwa*, *myinwa*, *wanwè* and *thaikwa*: fairly rich in teak.	Mr. G. E. S. Cubitt.
(*9*) 99·6	82	82		

Estimate of number of Padauk trees

Forest Division.	Name of Reserve.	ESTIMATED NUMBER OF SOUND PADAUK TREES 3′ AND OVER IN GIRTH OVER WHOLE RESERVE.		
		Total productive area of reserve in acres (*i.e.*, area for which stock has been estimated).	Total number estimated number of trees in reserve.	Estimated number of trees per 100 acres.
Pyinmana - *contd.*	Yanaungmyin, Kaing and Palwe.	119,255	15,171	13
„ .	Yônbin	73,252	4,146	6
„	Minbyin	117,183	9,234	8
„ .	Yeni	37,525	8,734	23
„ .	Ziaing and Mehaw . .	12,262	3,125	25
Toungoo . .	Saing Working Circle .	(108,384	33,724	31

per 100 acres in various localities—contd.

Number of sound padauk trees 3′ and over in girth enumerated in the sample-plots richest in padauk.			Remarks.	Author of Working Plan.
Area of sample-plot in acres.	Total number of trees in sample-plot.	Number of trees per 100 acres.		
(*10*) 78·6	59	80	In Pegu Yoma. Padauk scattered throughout the area except in very moist localities containing canes and evergreen, in which also teak is scarce or absent. (*10*) Teak and *pyinkado* fairly plentiful; chief bamboos *kyathaungwa* and *tinwa*.	Mr. C. W. Doveton.
(*11*) 66	31	47	In Pegu Yoma. Forest generally of a moister nature than the first four reserves above. Prevailing bamboos *kyathaungwa* and *tinwa*. Rich in *pyinkado*. (*11*) Padauk on the ridges and spurs mixed with *pyinkado*, on sandy loam. Absent on flat ground.	Mr. R. S. Troup.
(*12*) 63	72	114	In Pegu Yoma. Forest similar to that of the Yônbin. (*12*) Forest fairly dry, soil sandy loam; teak plentiful, with excellent reproduction. Bamboos *kyathaungwa*, *tinwa* and much *wanwè*.	Mr. S. Carr.
60·7	(*13*) 343	565	In Pegu Yoma. Areas containing no padauk are usually very moist with large *kyathaungwa* bamboos, and tending to evergreen with canes in the valleys. (*13*) This sample-plot is abnormally rich in padauk, the number not being approached by that in any other sample-plot in the reserve; the forest in this sample-plot is dry, with teak plentiful, and *wanwè* the prevailing bamboo.	Mr. S. Carr.
101·6	206	203	East of Sittang river. Padauk on sandy loam along the foot of a range of steep hills, in patches with rich teak.	Mr. F. H. Todd.
47	(*14*) 502	1,068	Pegu Yoma . . . . . . (*14*) In this rich sample-plot the soil is sandy loam and the chief bamboos *wapyu* (*wanwè* of Pyinmana) and *kyathaungwa*, with *tinwa* and *thaikwa* less abundant.	Mr F. J. Branthwaite.

Estimate of number of Padauk trees

Forest Division.	Name of Reserve.	ESTIMATED NUMBER OF SOUND PADAUK TREES 3′ AND OVER IN GIRTH OVER WHOLE RESERVE.		
		Total productive area of reserve in acres (*i.e.*, area for which stock has been estimated).	Total number estimated number of trees in reserve.	Estimated number of trees per 100 acres.
Toungoo . .	Kyaukmasin . . .	25,432	212	1
,, . .	Gwethe	30,871	8,552	28
Thayetmyo .	E. Yoma, Satsuwa and Tindaw.	85,346	17,123	20
Prome . .	North Nawin . . .	38,208	2,596	7
,, . .	Middle Nawin . .	29,855	1,322	4
,, . .	Chaungzauk . . .	34,552	4,197	12
Ruby Mines .	Maingtha, Kunchaung and Nanme.	224,063	34,430	15
,,	Nanhsin, Nampaw and Subok.	92,396	27,615	30
Lower Chindwin	Sindon	8,640	(*17*) 5,760	67

per 100 acres in various localities—concld.

NUMBER OF SOUND PADAUK TREES 3′ AND OVER IN GIRTH ENUMERATED IN THE SAMPLE-PLOTS RICHEST IN PADAUK.			REMARKS.	Author of Working Plan.
Area of sample-plot in acres.	Total number of trees in sample-plot.	Number of trees per 100 acres.		
62·8	22	35	Pegu Yoma	Mr. A. M. Burn-Murdoch.
68·8	72	105	East of Sittang river. Upper mixed teak forest with *kyathaungwa* and *tinwa* bamboos. Soil a coarse sandy loam.	Mr. F. J. Branthwaite.
(*15*) 219	186	85	Pegu Yoma, western slopes . . (*15*) Locality hilly, soil sandy loam; padauk mixed with teak, and *myinwa*, *kyathaungwa* and *tinwa* bamboos.	Mr. A. Rodger.
53	24	45	Pegu Yoma, western slopes . .	Mr. J. Messer.
57	27	47	Pegu Yoma, western slopes. Padauk absent in many compartments.	
50	35	70	Pegu Yoma, western slopes . .	
78·9	105	133	Hilly country, with gneiss, limestone, sandstone and shale. Padauk found chiefly in the drier forest, often with teak, the chief bamboos being *thanawa* and *tinwa*. Padauk chiefly on the edge of *indaing* forest.	Mr. H. L. P. Walsh.
(*16*) 49·3	241	489	Hilly country, hills rising to 2,700 feet. Soil sandy loam to rich red clay or lighter clayey loam. (*16*) In this sample-plot the soil is a deep loam, and the bamboos are *thanawa*, *tinwa* and *thaikwa*, the forest being of a rather dry nature.	Ditto.
...	...	...	(*17*) From linear valuation surveys made over 90 acres in 1894; size of trees, however, not stated. Rock sandstone, soil sandy loam. Hilly country, rising to 2,600 feet.	...

The relative density of Padauk, as compared with other principal species, is shown in the table given below, the figures in which have been compiled from the various working-plans mentioned above. In this table the climatic conditions of the various localities are given as far as can be ascertained.

RELATIVE DENSITY (PER CENT.) OF PADAUK AND OTHER PRINCIPAL SPECIES (SOUND TREES 3 FEET AND OVER IN GIRTH).

Relative density (per cent.) of Padauk and other

Forest Division.	Reserve.	Spe-				
		Padauk	Teak.	Pyinma (*Lagerstrœmia Flos-Reginæ*).	Pyinkado (*Xylia dolabriformis*).	Kanyin (*Dipterocarpus alatus*).
Pyinmana	Sinthe	*3·2*	7·6	...	9·5	...
	Pozaungdaung	*1·0*	7·1	0·5	12·2	1·3
	Taungnyo	*1·4*	12·0	0·1	12·7	1·6
	Ngalaik	*1·4*	20·0	0·1	16·6	0·6
	Yanaungmyin, Kaing and Palwè.	*0·9*	13·9	0·1	14·9	0·9
	Yônbin	*0·3*	12·1	0·5	21·5	1·0
	Minbyin	*0·4*	10·4	0·5	15·5	1·1
	Yeni	*0·9*	12·3	1·0	14·1	0·8
Toungoo	Saing Working Circle	*1·7*	6·5	1·0	17·1	2·8
	Kyaukmasin	Negligible.	13·1	0·1	16·7	1·5
	Gwethe	*1·0*	5·8	0·3	8·1	1·2
Thayetmyo	E. Yoma, Satsuwa and Tindaw.	*1·0*	15·0	0·05	13·0	0·2
Prome	North Nawin	*0·4*	15·0	0·4	17·9	...
	Middle Nawin	*0·2*	15·9	0·3	18·6	...
	Chaungzauk	*0·7*	15·9	0·3	17·5	...
Ruby Mines	Nanhan, Nampaw and Subôk.	*1·4*	11·7	2·1	...	...

principal species (sound trees 3 feet and over in girth).

CIES.					CLIMATE CONDITIONS (APPROXIMATE ONLY).			
Thingan (*Hopea odorata*).	*Ingyin and Thitya (*Pentacme suavis* and *Shorea obtusa*).	*In (*Dipterocarpus tuberculatus*).	Cutch (*Acacia Catechu*).	All others.	Maximum temperature (Fahr).	Minimum temperature (Fahr.).	Average annual rainfall (inches).	REMARKS.
...	13·1	1·3	0·1	65·2	109°	48°	45	* The number of *In, Thitya* and *Ingyin* given applies in most cases only to teak-bearing forest and not to *indaing* in which the species are typically found. The figures given for these species are therefore not correct for the whole reserve in the case of those reserves which contain large tracts of *indaing*, as enumerations were not as a rule carried out in this class of forest.
...	10·4	11·8	...	55·7	105°	50°	60	
...	10·5	6·5	...	55·2				
...	1·3	0·1	...	59·9				
0·1	2·6	2·6	...	64·0				
0·1	1·1	0·3	...	63·1				
0·1	4·2	1·3	...	66·5				
0·1	2·5	1·4	...	66·9				
0·5	3·2	5·1	...	62·1	106°	49°	75	
0·2	4·5	0·1	...	63·8				
0·2	12·1	32·3	...	39·0				
0·05	7·0	0·7	0·3	62·7	109°	44°	45	
...	2·3	0·3	...	63·7	109°	49°	46	
...	1·5	...	0·3	63·2				
...	0·5	0·2	5·7	59·2				
...	...	...	...	84·8	...	...	...	

7. Reproduction.

Natural Reproduction.—As a rule the reproduction of Padauk is reported to be good only in very dry areas, for example in the dry forests of the Kanbalu Range in the Mu Division. In the Yaw Division it is said to regenerate itself well both inside and outside fire-protected areas. In all other Divisions reproduction is reported to be only fair to poor. In the Ruby Mines Division Mr. Walsh remarks that natural reproduction is only fair in a few of the more open spots in the dry mixed forest. In the moist forests it is almost entirely absent. Further observations regarding the natural reproduction and sylviculture of the tree in different localities are, however, desirable. The seedlings suffer from browsing by deer.

Padauk is undoubtedly a light demander, but not so markedly as teak. Although it often seeds profusely, the seed as a rule has a very low germinating percentage. Mr. C. B. Smales remarks that low cover is favourable to its germination. The winged fruits blown by the wind, have a tendency to lodge in depressions and between stones and clods of earth, and seedlings are to be found chiefly in such places. Germination takes place during the first showers, before the rainy season sets in, and while the temperature is still high.

Artificial Reproduction.—Plantations of Padauk have been tried in several Divisions, generally with little success, while experimental dibbling of seed has also proved a failure so far. In the Toungoo Division plantations were made in 1904-1905. The Padauk seedlings were planted 3 feet apart in rows 12 feet apart with a row of *Albizzia Lebbek* between each row of Padauk. In 1906 the Padauk were reported to be doing well, but in many cases the leading shoots had been browsed off by deer, while weevils also killed off the young shoots by ringing the bark. In the Pyinmana Division plantations have been tried without success, but the locality is reported to have been badly chosen. In the Mu Division artificial reproduction was tried on a small scale in 1904-1905, in the Kanbalu range, but the experiment was a failure. Seeds were sown in small patches 6 feet apart along a strip which had been cleared of jungle. In the Minbu Division (Magwe District) a Padauk *taungya* plantation was formed, after the fashion of a Teak *taungya*, in 1904, but it proved almost a complete failure. In the Thaungyin, West Salween, Ataran and South

Tenasserim Divisions Padauk plantations on the *taungya* plan have been tried, the Padauk having been mixed with Teak in the two first named Divisions. The results were unsuccessful, the want of success in the Teak mixtures being attributed to the fact that the Padauk seedlings were rapidly outgrown by the young Teak plants. In South Tenasserim the lack of success is attributed partly to browsing by deer. Experiments are also being tried in that Division of planting seedlings in rough lines under light shade in the forest.

It has been suggested that seed which has hung long on the tree loses its germinating power, and that if fresh seed were collected a higher germinative percentage would result than has been obtained hitherto ; this requires verification, but it is a point worth testing practically. Experimental sowings of Padauk made in 1906 in Pyinmana Division gave very poor results, but in May and June 1907 a number of the seeds germinated under cover, and as Mr. Smales, the Divisional Officer, observes, Padauk seed should be sown not later than April.

It has been found that in nurseries the young Padauk seedlings are much subject to the attacks of crickets.

8. Description and Size of Tree.

Description.— The Burma Padauk is a large deciduous tree with grey bark, which on being blazed exudes a bright red astringent gum, similar in appearance to the kino of Pterocarpus Marsupium ; in the hot season, when it is leafless, it can be distinguished by this character as well as by the dry winged fruits which hang on the tree after the leaves have fallen. Large trees are often buttressed.

Dimensions.—Considerable diversity has existed in past writings regarding the size of the tree. Brandis, writing in 1860 on the forests of the Ataran valley,* says " Padauk trees of large size, up to 15′ in girth, occur occasionally in this forest. I met with a number of logs of large girth cut, but which had been left lying in the forest, as after cutting they were found too heavy for removal." Again he remarks, in a teak valuation survey in the Lower Winyeo forest, " Padauk scarce, but of immense girth."

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* Brandis, Report on the Attaran Forests, 1860, page 57.

Kurz, in his Preliminary Forest Report of Pegu,* classes Padauk (*Pterocarpus indicus* of his report, subsequently determined by Prain as *P. macrocarpus*, Kurz) among the lofty trees of the "closed tropical forests," in which "the average height of the trees ......ranges from 150 to 200 feet, rarely less; trees of 250 feet in height are of no rare occurrence." In his Forest Flora of British Burma, however, he gives the height of *Pterocarpus indicus* as 50 to 80 feet and that of *P. macrocarpus* as 30 to 50 feet, (both these, as we now know, belonging to the latter species).

It is quite probable that since the days of Brandis and Kurz the largest sized trees in accessible localities have been cut out to make solid Burmese cart-wheels. I have seen old solid Padauk cart-wheels in Upper Burma made from slabs of a size which would be difficult to obtain now-a-days in accessible localities, and Brandis' reference quoted above, to large trees having been felled and left lying, would seem to indicate that the tree has been rather wastefully cut in some localities in the past.

Few accurate height measurements of Padauk trees have been made. Mr. H. L. P. Walsh notes that the largest tree hitherto actually measured during the marking of trees for felling in the Ruby Mines Division was 12 feet 9 inches in girth at breast height. Mr. F. J. Branthwaite records a tree in the Toungoo Division measuring 100 feet in height and 10 feet in girth with a clear bole of 24 feet. Mr. D. H. Allan states that he has seen a tree estimated to be 90 feet high and 9 feet in girth in the Myittha Division. It is probable, therefore, that the Padauk tree only exceptionally reaches a height of 100 feet and a girth of 12 feet. Ordinarily it grows to a height of 50 to 70 feet with a clear bole of 20 to 40 feet and a girth of 4½ to 6 feet, the dimensions being greater in more favourable localities, while in unfavourable or very dry localities they are considerably less. Trees of large girth are nearly always hollow in the centre.

Exploitable Size.—Where the felling of Padauk is prescribed by rules in the Pyinmana Division the minimum girth limit for felling is usually fixed at 6 feet. Trees sometimes become hollow, however, before they reach this girth ; for cart-wheel naves trees of medium size (about 4 feet 6 inches in girth) are considered best. In the Taungdwingyi forests of the Minbu Division a minimum felling limit, for sound trees, of 6 feet girth is taken, unsound and crooked trees of lower dimensions being also felled. In the Ruby Mines Division 7 feet is taken as the minimum girth limit in the most favourable localities and 6 feet elsewhere ; in the rough working-plan for Padauk in the Myadaung and Thabeitkyin Ranges, however, 7 feet 6 inches is taken as the minimum girth limit for the felling of over-mature trees.

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* Kurz, Preliminary Report on the Forest and other Vegetation of Pegu, 1875, page 31.

Rate of Growth.—Attempts have been made to ascertain the rate of growth of Padauk by counting rings on stumps, but an accurate estimate is impossible owing to the indistinctness of the rings. The only method of finding the rate of growth will be to record periodical measurements of trees in sample-plots ; this has not yet been started systematically.

Size of Timber Obtainable.—The measurements of some of the largest Padauk logs hitherto received in the Mandalay Depôt from the Ruby Mines Division are, according to Mr. C. V. Ryan, as follows : —

Length.	Centre girth.	Contents in cubic feet.
20	8′ 3″	85 1
18	8′ 5″	79·7
21	7′ 9″	78·8
22	7′ 4″	73·9
23	7′ 2″	73·8
26	6′ 6″	68·7
24	6′ 9″	68·3
16	8′ 3″	68·1
25	6′ 3″	61·0

These, however, are not the largest sized logs which the tree is capable of producing, because, as Mr. Walsh remarks with respect to Ruby Mines timber, it is at present difficult to extract logs over 20 feet in length, as they have to be raised on Burmese carts without any special mechanical aid and carted any distance up to 8 miles.

During the years 1903-04 to 1907-08, 419 logs were extracted from the Ataran forests, the average size of log being 42·3 cubic feet.

Of 1,659 Padauk logs extracted from various parts of Burma during the years 1903 to 1907 the average volume was about 39 cubic feet per log. For Padauk logs, therefore, 40 cubic feet for medium to large timber may be considered a fair general average. The average dimensions of 830 Padauk logs at the Madras gun-carriage factory in 1900 were stated to be 18 feet in length, 6 feet 7 inches in girth, and 50 cubic feet in volume. This may be taken to represent the average of the largest classes of Padauk.

Considerable differences exist as to sizes of logs which could ordinarily be extracted in various localities, Divisional Officers giving the following dimensions:—

Katha Division, length 18 feet, centre girth 4 feet.
Myittha Division, length 30—40 feet, centre girth 6 feet 6 inches.
(could be extracted by elephants, not by buffaloes).
Mu Division (Wuntho and Kyunhla Ranges), length 35 feet, centre girth 5 feet 6 inches (extraction, however, stated to be difficult).
Minbu Division, length 20 feet, centre girth 3 feet 6 inches.
Pyinmana " " 20 " " " 5 feet.
Toungoo " " 18 " " " 4 feet 6 inches.

The average size of 227 squares of Burma Padauk shipped to London from South Tenasserim in 1905 was 17·6 cubic feet.

9. Description and Properties of Wood.

Grain, Colour, etc.—*Sapwood* light yellowish brown, small (about 1″—2″ thick in logs of 4½ feet girth and over). *Heartwood* bright yellowish red to dark brick red, sometimes streaked with brown, hard, close-grained, with fairly large pores, somewhat cross-grained, requiring a sharp plane to plane it smooth; has a very agreeable odour. Furniture makers report that the wood works well in spite of its hardness, turns well, and takes a good polish. In colour, however, it cannot compare with the best classes of Andaman Padauk (*P. dalbergioides*).

Seasoning Power.—Burma Padauk seasons well, without warping, but is somewhat apt to develop cracks in seasoning if felled green; Burmese wheelwrights use only wood from dead trees, and often plaster the ends of wheel-pieces with cowdung or smear them with earth-oil to prevent cracking. The wood is said to be easier to saw green than dry, but in any case it is difficult to saw owing to its hardness.

Durability.—Padauk is extremely durable. I have seen old solid Padauk wheels in Upper Burma which had lain on the ground for many years, but which were absolutely sound. Mr. C. V. Ryan states that logs which have lain in the Mandalay depôt for a couple of years, exposed to the weather, show no signs of rot or insect attacks, though they often develop sun-cracks.

Padauk lasts well underground and in contact with water. It is, however, not proof against the teredo-borer, as evidenced by logs lying in brackish water at Moulmein, which have been attacked by the marine worm.

Weight.—The weight of Padauk has been determined from the following specimens (seasoned heartwood):—

No. of specimen in Dehra Dun Collection.	Whence received.	Weight per cubic foot.
B. 4909 . . .	Upper Burma (C. T. Bingham) . . .	58
B. 5267 . . .	Mu Division, Upper Burma . . .	59
B. 5268 . . .	Myittha Division, Upper Burma . . .	52
B. 5279 . . .	Bhamo Division, Upper Burma (G. E. S. Cubitt).	53
B. 5286 . . .	Ruby Mines Division, Upper Burma (H. L. P. Walsh).	56
B. 5287 . .	Lower Chindwin Division, Upper Burma .	53
B. 5288 . . .	Ditto ditto .	55
	Average .	55

Strength.—Professor Everett, of Sibpur Engineering College, in 1908-1909 carried out tests with three samples of Burma Padauk and obtained the following results:—

Locality from which the sample was received.	Shearing strength along the grain (tons per sq. in.).	Crushing strength along the grain (tons per sq. in.).	Bending strength (tons per sq. in.).	Stiffness, from bending tests, E. (tons per sq. in.).	Corresponding value of P.*
Ruby Mines Division .	1·02	4·67	6·9	607	...
Myittha Division . .	0·995	5·52	6·45	611	...
Mu Division . .	1·12	6·52	6·4	455	...
Average .	1·045	5·57	6·58	558	819
Average for Teak† .	0·593	3·02	4·53	517	563
Average for Andaman Padauk† .	1·171	4·32	5·01	698	623

*$P = \frac{W \times L}{B \times D^2}$, where W is the breaking load in lbs., L the length of the bar, between supports. in feet, and B and D its breadth and depth in inches.

†From Professor Everett's "Memorandum on Mechanical Tests of some Indian Timbers" Forest Bulletin No. 6, 1906.

The above figures show that Burma Padauk is considerably stronger than Teak as far as shearing, crushing and bending strength are concerned, but is not much superior to it in stiffness. The comparison with Andaman Padauk (*Pterocarpus dalbergioides*) is interesting, the tests showing superiority of Burma Padauk over Andaman Padauk in crushing and bending strength and *vice versâ* in the case of shearing strength and stiffness. Of the 37 Indian species tested by Professor Everett and reported on by him in 1906, no wood surpasses Burma Padauk in all four qualities of strength (shearing, crushing, bending, and stiffness). Only two woods (*Pterocarpus santalinus* and *Mesua ferrea*) surpass it in crushing strength, six woods in shearing strength, seven in bending strength, and no fewer than twenty-one in stiffness. From this it would appear that Burma Padauk does not possess exceptional elasticity, but as far as resistance to crushing goes it is one of the strongest of woods, while in shearing and bending strength it is also much above the average. These are among the qualities which render the wood such a superior one for wheel-work, while owing to the resistance of the wood to crushing it may be expected to give good results as a paving-block wood.

From tests made in 1905 at the Gun-Carriage Factory, Madras, with bars 16″ × 1″ × 1″ of Ruby Mines Padauk, the following results were obtained:—

No.	Breaking load (lbs.).	K. (Co-efficient of rupture).	P. (as above).
1	702	25·04	
2	646	23·04	
3	758	27·04	
4	842	30·04	
5	758	27·04	
6	870	31·04	
Average .	763	27·21	1017

The value of P. here is considerably higher than that obtained from Everett's tests, but it should be noted that Everett used much larger specimens for his tests.

Mr. Stone's Report.—A specimen of Burma Padauk was sent in 1907 to Mr. Herbert Stone, of Birmingham, the well known expert on timbers. He has kindly furnished me with the following report regarding it:—

> "I have met with this species under the name of 'Brown Padauk.' It is a good marketable wood, but suffers from comparison with the more favoured *P. dalbergioides*. The latter is prized here solely on account of its colour, and the excellent way it finishes, so that the name 'Brown Padauk' leads buyers to expect something of the same kind, to their disappointment. It

is much more porous than the other species, finishes indifferently, and is not esteemed as a furniture wood at present. With attention it may gain a footing for itself, but so far very few users know the wood at all. I find the specimen brittle and cross-grained, and hard to saw and plane; pieces rip out here and there, making the levelling of the surface difficult. The aroma is very agreeable. It takes a good finish, but the grain requires much filling, and a good deal of time must be spent upon it to produce the best effect. The Padauk mentioned by Laslett (I have his specimen) is the present species."

10. Felling and Extraction.

System of Working the Forests.—Padauk is worked on the selection system under sylvicultural rules with a fixed minimum girth limit which varies in different localities. Prescriptions for the working of Padauk are laid down in some of the Teak working-plans.

The first working-plan for Padauk alone was that drawn up in 1905 by the late Mr. C. W. A. Bruce for the extraction of mature and over-mature Padauk from the forests of the Myadaung and Thabeitkyin Ranges, Ruby Mines Division. Under this plan 7 feet 6 inches at breast height has been taken as the minimum girth limit, unsound trees of smaller girth being also taken if there are other trees or young growth around them. A rough working-plan for the Padauk forests of the Shweli Range has since been drawn up by Mr. Walsh as an addendum to that of the Myadaung and Thabeitkyin Ranges.

In Mr. Walsh's working-plan of the Nanhan, Nampaw and Subôk forests of the Ruby Mines Division 7 feet has been taken as the minimum girth limit in a few compartments and 6 feet over the remainder of the area. In certain compartments of the Nanme Reserve of the same Division 8 feet is taken as the minimum felling girth for sound Padauk trees. In Mr. Leete's working-plan of the Taungdwingyi forests of the Minbu Division the minimum girth limit is fixed at 6 feet, with the proviso that unsound and crooked trees of lower dimensions may be felled. The local demand is for small trees about 3 feet 6 inches in girth for cart-wheel naves.

In the Pyinmana Division Mr. Linnell's working-plan of the Sinthe Reserve prescribes 6 feet as the minimum girth limit. In Mr. Cubitt's working-plan of the Ngalaik Reserve, in the same Division, the minimum girth limit is taken at 6 feet for large Padauk timber and 4 feet 6 inches (more or less, at discretion) in certain areas, for cart-wheel naves.

Felling and Extraction.—Timber supplied to the Ordnance Department is felled green, as that Department will not accept wood felled dry. The Burmans prefer the wood from dead or girdled trees, but systematic girdling, as in the case of Teak, is not generally carried out by the Forest Department, though it has been done in the Ataran Division. In some Divisions the felling of green Padauk for local use is prohibited outside reserves, only dead trees being permitted to be felled. Inside reserves the selection of trees, as stated above, is governed by the prescriptions of working-plans, and where no working-plans exist the working is generally confined to dead and fallen trees.

Many Forest Officers recommend the systematic girdling of Padauk on the ground that the wood will be less liable to split in seasoning than if felled green, and this opinion is certainly substantiated by the experience of Burmese wheelwrights, who use the wood of dead trees for wheel-hubs and not wood felled green, as the latter is more liable to crack. Another advantage of girdling would be that the timber will nearly if not entirely float without the aid of bamboos, and will at any rate float much higher with their aid than green wood.

Contractors do not as a rule care to work Padauk, because the wood is hard, and the larger trees are often buttressed as well as hollow at the base and full of earth, necessitating a second cut after the tree is felled in order to cut off the earth-filled butt. It is heavy to drag, will not float, and has to be rafted with the aid of bamboos ; this is a risky business, especially in bad weather, as the rafts at the best of times float low and require extra trouble and skill to manage, and stronger ropes than usual. It is therefore as a rule necessary to give extra rates to contractors for working large-sized Padauk.

The smaller floating streams cannot be utilized for the extraction of Padauk logs as they can for teak, because the former will not float in the green state in which they are required by the

Ordnance Department. For this reason Padauk logs have to be dragged or carted, or both, to the nearest rafting stream, and thence rafted to their destination with the aid of bamboos. The dragging is usually done by buffaloes, and exceptionally, in the case of large logs, by elephants. In all but the most accessible localities *padaungs*, that is, pieces to be used for cart-wheel naves, are roughly converted in the forest and carted out.

Export Trade.— Apart from the export of timber to India for Ordnance work referred to below, Padauk has in the past been shipped to England, America and India by a European Firm, and the trade gave promise of successful development, buyers preferring the Burma wood to Andamans Padauk for purposes where strength and toughness were concerned. The raising of the Government royalty to a higher rate than the trade would stand, however, completely killed this export trade, which has in consequence dropped entirely. It is hoped that the recent lowering of the duty rates on this timber will have some effect in stimulating a revival of the trade.

Local Trade.—Local trade in Padauk is almost entirely confined to *padaungs*, which are short pieces cut from dry straight branchwood or dry trunks of trees of medium girth, for the manufacture of cart-wheel naves. These *padaungs* are usually 2 feet to 3 feet in length by 2 feet to 3 feet in girth, according to the class of wheel, and each *padaung* yields two naves. The stems of trees yielding *padaungs* are commonly 3½ to 4½ feet in girth at breast height, and the pieces when cut have the sapwood, or the rough exterior parts in the case of trees long dead, trimmed off before they become saleable *padaungs*.

Extraction by Departmental Agency. — Padauk is extracted by departmental agency in the Ruby Mines, Pyinmana, Mu (dead and fallen timber only), Thaungyin and Ataran Divisions and has been extracted in past years in small quantities in the Mandalay, Shwegyin and other Divisions. Most of the departmentally worked Padauk has been extracted for shipment to the Gun-Carriage Factory, Madras, in the form of specially selected timber of fairly large dimensions. A quantity of Padauk timber was extracted departmentally in South Tenasserim Division and shipped to London for sale in 1905.

The cost of extraction varies with the locality, but the following figures show approximate cost of delivery at various centres and railway stations:—

Forest Division.	Place of delivery.	Approximate rate of delivery. (*N.B.* 1 ton = 50 cubic feet.)	Remarks.
Myittha	Alon	R35 per ton (round).	Includes Government duty of R20 per ton.
Mu	Kadaungbo Kawlin Kyaikthin Tantabin Kanbalu	R75 per 100 pairs of wheel-hubs (=2·5 tons).	Actual cost of delivery without reckoning duty.
Ruby Mines	Mandalay	R20 per ton (round). R22 per ton (round). R25 per ton (round).	From Irrawaddy forests. From Shweli forests. From Upper Shweli forests. Actual cost of delivery without reckoning duty.
	Rangoon	R14 per ton above Mandalay rates (for timber sent by rail).	It is more risky, and nearly as expensive, to raft Padauk from Mandalay to Rangoon.
Minbu	Rangoon	R60 per ton (round).	
Pyinmana	Local railway stations.	R1 per *padaung*, R7 to R10 per log 15—20 feet long.	Actual cost of delivery without reckoning duty.
	Rangoon	R40 per ton (round).	
Prome	Prome	R40 per ton (round).	
	Rangoon	R45 per ton (round).	

Forest Division.	Place of delivery.	Approximate rate of delivery. (*N.B.* 1 ton = 50 cubic feet.)	REMARKS.
Toungoo	Oktwin	R15 per ton (round).	Actual cost of delivery without reckoning duty.
	Toungoo	R18 per ton (round).	
	Myohla		
	Thagaya		
	Yedashe	R16 per ton (round).	
	Rangoon	R4-8 in addition to above rates.	
Shwegyin	Rangoon	R20 per ton	Ditto.
Thaungyin	Moulmein	R57 per ton.	
South Tenasserim.	Tavoy anchorage.	R60 per ton	*f. o. b.*
	Rangoon	R73 per ton.	

Extraction by Licensees.—Extraction by licensees is almost wholly confined to the working of dead wood in the form of *padaungs* and is carried out in most of the Forest Divisions where Padauk is worked, including many of those in which departmental extraction is aslo carried out. The duty on Padauk timber was formerly too high to permit of any extensive trade being done by licensees but it has recently been reduced considerably, and an increase in the quantity extracted may be anticipated. The duty rates are now—

R20 per ton in the Northern Circle.
(R15 per ton in Pyinmana Division.)
R25 per ton in the Southern Circle.
(R15 per ton in Pyinmana Division.)
R20 per ton in the Pegu Circle.
R25 per ton in the Tenasserim Circle.

II. Demand and Prices.

Ordnance Department Timber.—The best quality of large sized Padauk timber is sold to the Ordnance Department at R100 per ton, and as this demand swallows up the greater portion of the best timber, local market prices as a rule refer to timber below the average. For converted slabs from Mandalay the Ordnance Department has recently paid R85 per ton plus *o.b.* charges.

Depression in Trade.—For logs rejected by the Ordnance Department there was formerly a good demand, but latterly, and especially in 1906-07, it has been difficult to sell departmentally extracted Padauk timber in Rangoon and Mandalay at remunerative rates. The precise reasons for this depression are not quite clear, but the prevalence of plague, with consequent depression in trade all round, no doubt had something to do with it. As an illustration of this depression in the Padauk trade, it may be mentioned that in 1904-05 short length logs sold at R94 and R80 per ton in Mandalay; in 1905-06 logs of a larger size fetched only Rs. 65 and Rs. 41 per ton, while towards the end of 1906 purchasers were still awaited for logs offered at the low rate of R40 per ton.

In the case of timber extracted by licensees there is no doubt that the former high rate of duty was primarily responsible for the decline of local trade in Padauk timber.

Local sales, Rangoon.— Government sales in Rangoon in past years have yielded the following prices, chiefly for timber rejected by the Ordnance Department:—

	R		R	
1903-04	60	to	86	per ton.
1904-05	41	to	100	„
1905-06	30	to	80	„
1906-07	20	to	100	„
1907-08	59	and	60	„

In addition, timber has been regularly sold to the Ordnance Department at R100 per ton for selected logs.

Mandalay.—In Mandalay within recent years 2nd class logs have been sold by auction at rates varying from R18 to R58 per ton. A few logs have been sold by private bargain at R40 and a few scantlings at R70 per ton, the latter being the same rate as for *Thitya* (*Shorea obtusa*).

Prices of "Padaungs."—The prices of short pieces (*padaungs*) for the manufacture of wheel-hubs do not appear to be subject to the same wide fluctuations as those of larger timber. The following are some of the local rates for *padaungs*:—

Mandalay Depôt.—The market rate varies from R200 to R225 per 100 pieces, or R80 to R85 per ton.

Mu Division.—The average price within the last two years has been R250 per 100 pieces, or about R100 per ton.

Pyinmana. —*Padaungs* of length 2 feet and girth 3 feet 8 inches have recently been auctioned for R2 each.

Toungoo.—Local prices are as follows:—

			R
Pieces of length 3 feet and girth	2 feet 3 inches	. .	300 per 100.
Ditto	ditto	2 feet	250 ,,
Ditto	ditto	1 foot 6 inches .	125 ,,

Ataran Division.— In 1905-06, 577 *padaungs* measuring 865 cubic feet were sold for R2,020, that is, at the rate of R350 per 100 or R117 per ton.

Foreign sales.— The few sales of exported Padauk which have hitherto taken place give little indication of what the wood is likely to fetch if exported in regular quantities, but it is not likely to command such high prices as Andaman Padauk owing to the richer colour of the latter. In 1901, 800 squares of Burma Padauk were sold in the American market at the rate of 3*s*. 6*d*. per cubic foot, as compared with 6*s*. 6*d*. obtained for Andaman Padauk. In 1905, 23 squares of Burma Padauk shipped from Tavoy were sold in London at the rate of 2*s*. 9*d*. per cubic foot.

12. Outturn.

Past Outturn.—During the 5 years 1903-04 to 1907-08 the quantity of Padauk timber extracted, both by Government agency and by licensees, probably did not exceed 600 tons per annum on an average, so far as available figures indicate. The quantity of Padauk brought into Rangoon Depôt during recent years is as follows:—

1902-03	115 tons.
1903-04	99 ,,
1904-05	767 ,,
1905-06	276 ,,
1906-07	80 ,,

Future Possible Outturn.—Until roads and other means of communication in the forests of Burma are considerably improved and extended, it is probable that the total possible annual outturn of Padauk in the province will not exceed 2,500 tons of timber in the round, together with a few hundred tons of small pieces, exclusive of what will be required for local use in the shape of cart wheel naves. With the construction of good forest roads the outturn should be greatly increased. Although enumerations of Padauk have been made in connection with several of the Teak working-plans, in many localities no such enumerations have been made ; in any case the absence of any data regarding rate of growth makes an accurate estimate of future outturn impossible. The following estimates, therefore, furnished by Divisional Forest Officers, are only very roughly approximate : —

Division.	Approximate annual quantity of timber available for export.	Remarks.
Myittha	100 tons	Only workable near Chindwin River.
Mu	200 tons	In addition to local demand, which is only for dead wood.
Katha	Negligible.	
Ruby Mines	800 trees	All available for export.
	200 tons of dry branch wood and small stem-wood.	
Mandalay	100 tons	This is the maximum permitted to be extracted per annum under ordinary conditions.
Minbu	……	40—50 tons available annually, but this could all be used locally.
Pyinmana	250 tons	In addition 50 tons are available annually to satisfy local requirements. The construction of roads should greatly increase the outturn from this Division.
Prome	300 tons	All available for export, but extraction very difficult.

Division.	Approximate annual quantity of timber available for export.	REMARKS.
Toungoo	400 tons.	
Shwegyin	Uncertain.	
Thaungyin	Uncertain	Quantity small, as Padauk cannot at present be extracted from the Thaungyin valley, where it is most plentiful.
Ataran	200 logs.	
South Tenasserim	10 tons.	

The Lower Chindwin, Thayetmyo and West Salween Divisions could probably also supply a certain quantity of Padauk annually, but figures have not been received from these Divisions.

13. Uses of Padauk.

Much erroneous information has been recorded regarding the uses of Burma Padauk through the confusion which existed between this wood and the Andaman Padauk (*Pterocarpus dalbergioides*). The red Padauk of the Andamans is prized chiefly for its richness of colour, and in this respect the Burma Padauk cannot compare with it. On the other hand for purposes where great strength, durability and good seasoning qualities are required, Burma Padauk is one of the best of timbers.

The chief uses of Burma Padauk are for Ordnance work (for which it is put to more uses than any other timber, and for which Andaman Padauk is not used), naves of Burmese cart-wheels (and to a lesser extent for cart-wheel spokes and felloes), cart-axles, solid Burmese cart-wheels, furniture (particularly strong camp furniture), house building (particularly interior ornamental work), carriage wheels, carriage frames and shafts, billiard-table cushions, tool-handles, oil-presses, wood-paving, boxes and general carpentry, ploughs, harrows and Burmese harps. According to Mr. R. E. Marsden, the shafts of some of the Irrawaddy Flotilla Company's steamers now turn in Padauk bearings instead of in brass or lignum vitae.

The following particulars are available regarding some of the uses to which Burma Padauk is put:—

Ordnance Work.—Burma Padauk was supplied to the Ordnance Department as early as the seventies. The chief articles for which the wood is used are spokes and felloes of wheels, handspikes, draught poles and poles of various kinds, yokes, swingle trees, frames of transport carts, tongas, and wheel-barrows, planking for store carts, bale-hoops, transport boxes, staves and heads of rammers for large guns, and heads of mauls. Prior to 1905 the Madras Gun-Carriage Factory received its supply of Padauk from Lower Burma, but in that year nine logs of Ruby Mines Padauk were received for trial, and were found to be of such good quality that supplies of Padauk have since been obtained from Upper as well as from Lower Burma. The specification of Padauk timber supplied to the Ordnance Department is very high. Timber has usually been supplied in the round, but recently it has been converted into scantlings in Mandalay. The sizes of scantlings most in demand are 3½ and 4½ inches in thickness, and the logs are sawn up in such a way as to produce slabs as wide as possible and with a thickness of 3½ or 4½ inches or a multiple of these. In converting, the heart flaw of the log is cut out and discarded. The recovery of converted material is 44 per cent. or more from large logs, and only 30—33 per cent. from small logs. Andaman Padauk (*Pterocarpus dalbergioides*) was in former years supplied to the Ordnance Department in the form of logs and squares, but complaints were made that the wood did not stand the seasoning process, was liable to "faults", seasoned quickly, and was liable to decay. Before seasoning the wood was first treated with hot lime solution and then cowdung and mud were plastered over it to prevent "rifting."

Furniture.— Padauk wood has been used to a considerable extent at the Mandalay jail for making furniture, carriage wheels and shafts, and cart-wheel naves. The Superintendent of the jail states regarding the wood: "It takes a very high polish, and the manufacture of furniture, especially camp furniture, has been a great success. Padauk is very hard and durable, but works well, and if the weight of the wood was lighter it would be preferable to teak for making furniture." It can be used, however, in pieces of smaller section than teak, owing to its strength, so that the weight is to some extent counteracted.

Paving-blocks.—Padauk is at present under trial for street-paving in Rangoon, 25,000 paving blocks having been supplied to the Municipality in 1906-07 and 26,440 in 1907-08. It is as yet too soon, however, to form any conclusions as to the merits of the wood for this purpose.

Further Uses.—Burma Padauk timber well deserves more extensive trial as a superior house-building timber for door and window frames, panelling, carving, polished floors, railway carriages, boat and ship building, cabinet-work and general carpentry. It is too scarce and valuable a wood for railway-sleepers, otherwise there are few woods which would equal it for the purpose. It is essentially a high-class hardwood.

14. Minor Products.

The minor products yielded by the Padauk tree are of small importance commercially. The scented flowers are used for decorations by the Burmese. A red astringent gum-kino is yielded by gashes made in the bark, but it is put to no use. The bark is sometimes used to poison fish. Mr. C. V. Ryan notes that a blue dye has been observed to exude from Padauk wood when soaked in water; nothing is known, however, regarding this dye.

Glossary of Vernacular Terms.

Indaing.— A type of forest, most frequently found on laterite, in which the prevailing species are *In (Dipterocarpus tuberculatus)*, *Thitya (Shorea obtusa)* and *Ingyin (Pentacme suavis)*.

Kyathaungwa.—*Bambusa polymorpha.*

Myinwa.— *Dendrocalamus strictus.*

Padaung.— A roughly-fashioned pair of wheel-hubs, in one piece.

Pyinkado.— *Xylia dolabriformis.*

Taungya (plantation).— A plantation raised along with field crops in a temporary forest clearing.

Thaikwa.—*Bambusa Tulda.*

Thanawa.—*Thyrsostachys Oliveri.*

Wanwe, Wapyu.—*Oxytenanthera albociliata.*

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BY

E. P. STEBBING, F.L.S., F.Z.S., F.R.G.S., F.E.S.,
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SECOND EDITION.

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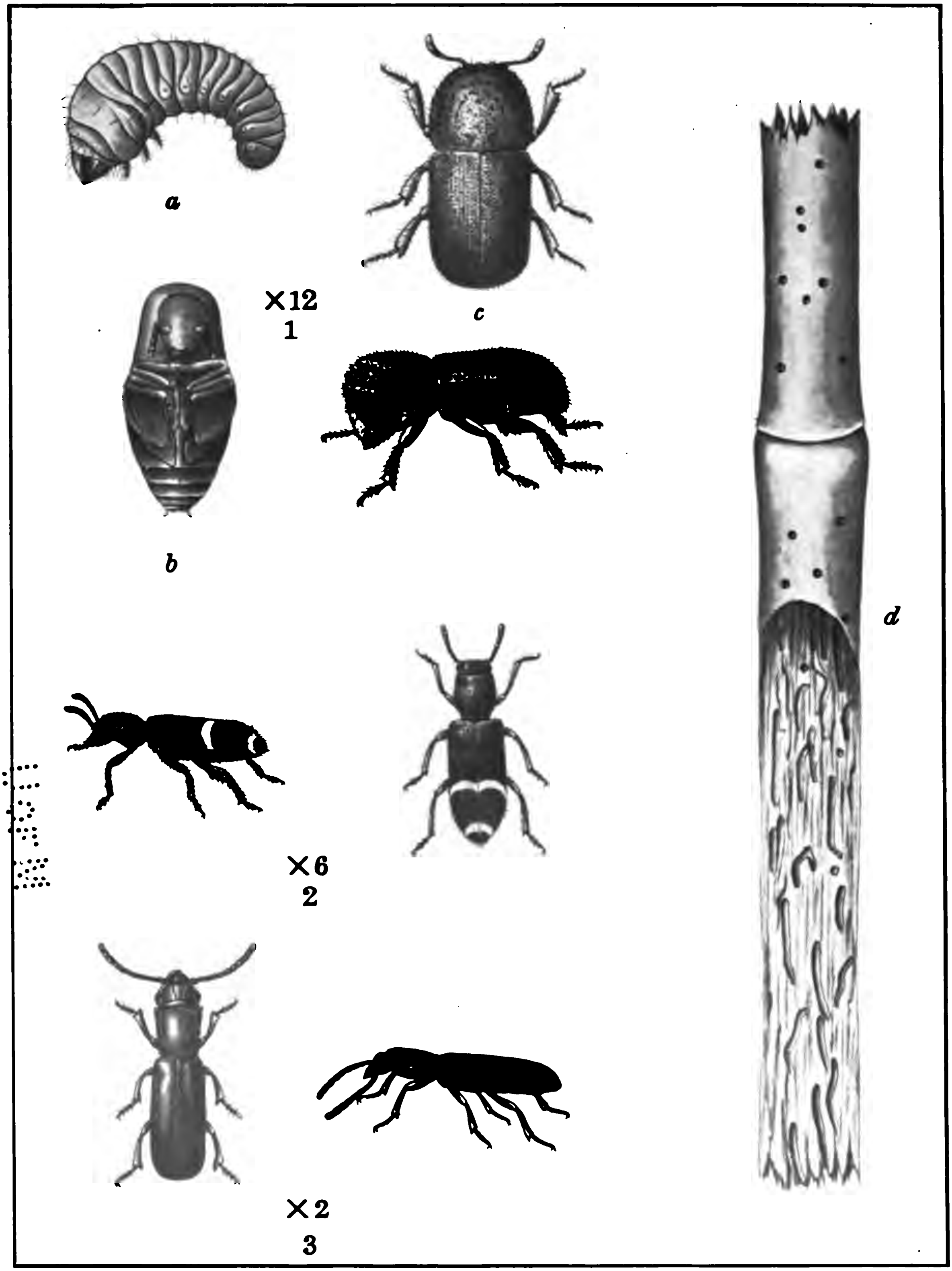
Stebbing—Bamboo beetles. PLATE I.



J. B. Sing, *del.*

Engraved & printed by Survey of India Offices Calcutta, 1910

1. **Dinoderus minutus, Lesne.** 2. **Thanasimus sp.** 3. **Hectarthron brevifossum.**

[*to face page 1.*

A Note on the Preservation of Bamboos from the attacks of the Bamboo Beetle or "Shot-Borer"

BY

E. P. STEBBING, F.L.S., F.Z.S., F.R.G.S., F.E.S.

General Remarks.

THE work of the bamboo beetle or "shot-borer," the *ghoong* of the Natives in many parts of the country, is well known in India. All who have anything to do with bamboos, either with their cutting and export, their use in buildings, or their manufacture into the thousand and one articles to which this most useful commodity is put in the country have to count upon and allow for the ravages of this pest and in many parts a year to a year and a half may be given as the estimated and probable life of a bamboo after cutting.

Description and Life-History of the "Shot-borer."

But although the results of its work are well-known, the real author of the depredations is far from being a well-recognised enemy owing both to its small size and to its secretive habits. The damage is committed by a tiny beetle and its grubs (see Plate I, fig. 1 a, b, c) which are of slightly smaller diameter than the holes with which the bamboos are seen to be riddled. The beetle, which has a black head and thorax and reddish-coloured shining wing covers (fig. c back and side view), bores its way into the bamboo and lays its eggs in the interior, each beetle laying about 20. From these eggs small, white, roundish dots of grubs issue within a few days of their being deposited. These tiny larvæ (fig. 1a) burrow up and down in the interior of the bamboo and reduce its structure to powder (fig. 1d). About four weeks are spent in this stage and the grubs then enlarge the ends of their burrows and change to pupæ or nymphs (fig. b) which after some eight days or so turn into the beetles. On becoming mature the beetles bore their way out of the bamboos and thus add further to the tunnels already made in them. On emergence the insects fly off to attack fresh bamboos or they may bore into the one in which they have matured themselves. There are thus three separate forms of attack:—

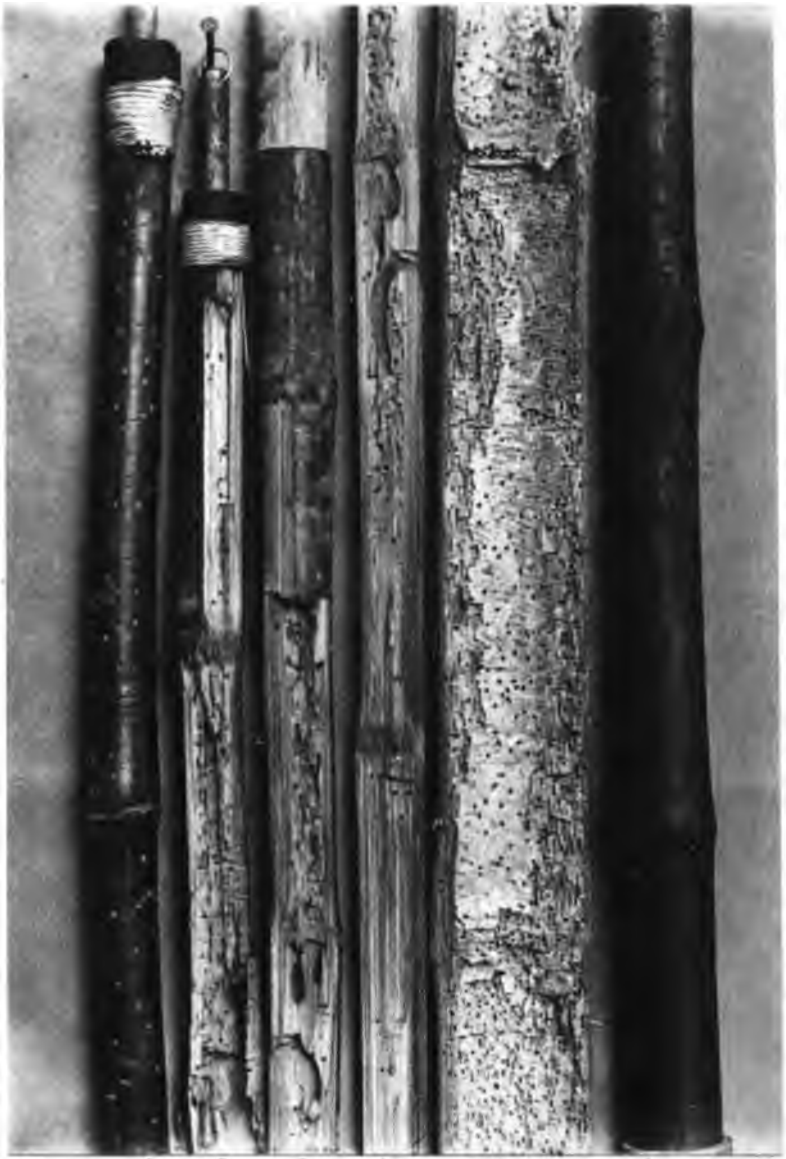
(*a*) The female beetle bores into the interior of the bamboo and lays its eggs there. This is the first attack on the bamboo and can be seen from the outside.

(*b*) From the eggs hatch out little grubs which feed upon the wood of the interior of the bamboo and thus undermine its strength. This attack is not visible from the outside.

(*c*) The beetles on maturing from the grubs bore their way out of the bamboo.

It used to be thought that each of the shot-borers made their way out by a separate tunnel, driven direct from the place where the grub had pupated to the outside. This is not, however, the case as the matured beetles appear to issue either all from the same exit hole or from one or two only, these being often the former entrance holes of the mother beetles which are considerably enlarged. Beetles of the new generation appear to also make use of these old holes to enter the bamboo to egg-lay, boring away from the old gallery when they have got inside. When bamboos are in lengths it will be found that the beetles tunnel in them parallel to the long axis and form galleries which open at one of the ends. The bamboo is thus often completely hollow in parts without there being much outward evidence of its having been badly attacked. This is more especially the case when the beetles have entered and left by the same holes, made at one of the ends of the bamboo. A feature which greatly adds to the insect's power of doing serious damage is to be found in the fact that in the warmer parts of the country it passes through at least five, and perhaps more, generations or life cycles in the year. I have said that the insect lays

Stebbing - Bamboo beetles. Plate II.



Photogravure Survey of India Offices, Calcutta, December 1903.

BAMBOOS TUNNELLED INTO BY THE BAMBOO BORER.

(*DINODERUS MINUTUS*) [to face page 11.

Captain A. Mc Cormick, R. E. Photo.

about 20 eggs and therefore one female beetle may produce the following progeny in the year on the supposition that only five generations are passed through:—

1 Female Beetle.

1st generation .	1 × 20 =	20 beetles, say ½ males and ½ females (the latter are, however, usually in excess of former).
2nd ,, .	10 × 20 =	200 beetles, say, ½ males and ½ females.
3rd ,, .	100 × 20 =	2,000 ditto.
4th ,, .	1,000 × 20 =	20,000 ditto.
5th ,, .	10,000 × 20 =	200,000 ditto.

If there is a 6th generation the number of females increases to 2,000,000.

Taking only 50 per cent. of the 5th generation beetles as maturing and laying eggs, we still have 100,000 insects as the progeny of the one mother beetle in the spring. This great prolificness easily explains why bamboos suffer so greatly from the shot-borer's attacks throughout the country.

With this brief sketch of the beetle and its mode of attack we will now turn to the consideration of a method of treatment by which the bamboos can be preserved at any rate for a time against the pest.

Experimental Treatment for Preservation.

Towards the end of April of his year (1903) Mr. Williams, the Superintendent of the Telegraph Workshops at Calcutta, informed me that bamboos which he was converting into field telegraph posts for use in frontier expeditions and elsewhere were being attacked and riddled by insects. The specimens he sent me I identified as the common bamboo-boring beetle.* As the question of the preservation of bamboos against this insect had been engaging my attention for some time, I immediately paid a visit to the workshops and examined the bamboos. I found that before being fitted up as telegraph posts, they were being experimentally treated in the following manner:—

(1) Five days' soaking in river water;
(2) Five days' soaking in a solution of copper sulphate, after which they were dried in a covered shed for several days; and then
(3) Soaked for 24 hours in common Rangoon oil.

---

* *Dinoderus minutus*, Lesne.

This latter has the effect of darkening the bamboos and the smell of the oil remains in them for some considerable time, although not so offensively as to prevent their being made use of. The treatment lasted about 14 days upon the expiration of which period the bamboos were at once sent to the workshops to the fitted.

Mr. Williams had reported that within three weeks of this treatment some of the bamboos had been again attacked by the borers. As some 9,000 had been through the treatment, many of which had been already fitted, the case afforded a good opportunity for experiment.

Having carefully examined all the bamboos and their method of treatment I was able, through the courtesy of the Superintendent, to obtain a number of specimens both untreated and in the various stages of treatment. With them it was my intention to initiate a series of experiments to determine the exact effect of any one or more of these preservative liquids as a deterrent to the attacks of the beetles.

The bamboos had been cut in the Garhwal Forests (United Provinces) and were obtained by the Telegraph Department at Najibabad near Bareilly having been floated down from the forests. They were, following the usual custom, passed through fire and straightened by the merchants before being sold.

The telegraph specification required the bamboos to have been cut during the cold weather of 1902-03, to be 8 feet in length or over with a diameter at the small end of not less than $\frac{7}{8}$ inch and not more than $1\frac{1}{4}$ inch. Only male bamboos, *i.e.*, solid ones, were to be included in the indent.

The bamboos were despatched in convenient lots from Bareilly and no especial protection was given to them on the journey down. They arrived in Calcutta mostly in February and March, the last batches only reaching, however, in April. They were not subjected to any treatment before the end of February, and consequently some of the bamboos were in the works for nearly a month before being operated upon. Those showing evidence of the presence of borers had therefore either become infested on the way down or in Calcutta itself. When the treatment the bamboos were to be subjected to had been decided upon, no time was lost in putting them through it. It was as the last batches of the bamboos were being subjected to the oil process that I visited the works. From previous observations I was of opinion that the beetles then appearing in the works were those of the 1st generation in the year, *i.e.*, they had developed from eggs laid probably at the end of February or beginning of March. I wished to try and find out—

(1) How many more generations of the beetle appeared in the year.

(2) Whether the oil treatment was of any use.

Experiments.

The bamboos I selected for my experiments were good examples of their class of treatment, and on receipt they were placed in boxes constructed of tin foil and provided with close fitting tops of wire gauze. The boxes were so made that there was no chance of anything inside getting out or anything from without getting in and they answered admirably. The whole series of experiments were personally carried out by myself in order to ensure accuracy in the observations and they lasted from the end of April till the end of November. In each box were placed specimens of differently treated bamboos. The experiments were commenced on the 29th April upon which date four boxes were got ready as follows:—

Experiment I.—Box contained untreated bamboos.

Experiment II.—Box contained bamboos which had been through the water process.

Experiment III.—Box contained bamboos which had been through the water and $CuSo_4$ (copper sulphate) processes.

Experiment IV.—Box contained bamboos which had been through the water, $CuSo_4$, and Rangoon oil processes.

A day or two afterwards three more boxes were prepared as follows:—

Experiment V.—Bamboos treated up to and including $CuSo_4$.

Experiment VI.—Fully treated bamboos.

Experiment VII.—Fully treated bamboos.

The idea was to endeavour to ascertain what portion or portions of the treatment were effective against the borer, it being assumed that the bamboos experimented with contained or had contained eggs or grubs or beetles at the time they were put into the boxes. These latter were examined weekly or at lesser intervals. I propose to give *in extenso* the observations noted during the first month, in order that the manner in which the experiments were carried out may be clearly understood, subsequent months being shortly summarised.

During the first month, *i.e.*, up to the 26th May, the following observations were recorded:—

Experiment I.—Untreated bamboo—No boring apparent at first. On the 12th May dead beetles, which had issued from the bamboo after egg-laying, found at bottom of box. 18th May—More dead beetles and one living one at bottom of box. A considerable amount of saw-dust, the result of the burrowing operations of beetles and their larvæ, at bottom of box. May 26th—Dead and living beetles taken from box. Considerable heaps of saw-dust present. (I may note that after each inspection all saw-dust was swept up into one corner of the box so as not to interfere with future observations.)

Experiment II.—Water process—This bamboo showed no signs of having been attacked on being placed in the box. No signs were visible up to May 26th.

Experiment III.—$CuSo_4$ process—No signs of attack on April 28th or afterwards up to May 26th.

Experiment IV.—Oil process—The bamboos had been attacked previously to the treatment. No further signs of attack up to May 26th.

Experiment V.—$CuSo_4$ process—Bamboos badly attacked. May 12th—Ten dead beetles found at bottom of box and a large amount of boring was going on inside the bamboos as evidenced by the piles of saw-dust all over the bottom of the box. May 18th—Five beetles at bottom of box, all dead, and a large amount of saw-dust. May 26th—Twenty-two beetles, mostly alive, taken from the box. Saw-dust plentiful. [A predaceous beetle* (see Pl. I, fig. 3) and a parasitic ichneumon fly were also taken from the box.]

Experiment VI.—Previous to being treated this bamboo had been badly attacked by the beetles which had bored in to lay eggs, numbers of which must have been deposited within the bamboo. No evidence of any fresh borings in the interior of the bamboo up to May 26th.

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* *Hectarthron brevifossum.*

Experiment VII.—This bamboo had been slightly attacked before treatment. No subsequent attacks up to May 26th.

On the 18th May I received and examined a very badly riddled bamboo sent by Mr. Williams. He stated that it had been through all the processes: yet it swarmed with the beetles. On examination it appeared to me that the bamboo had not been thoroughly subjected to the oil process. It was light coloured, but little greasy to the touch, and smelt but slightly of the oil. As I was becoming convinced that the water and $CuSo_4$ processes alone afforded no protection, I wrote to the Superintendent pointing out that it was possible that some of the bamboos at the top of the heap in the oil tank had probably not been as well soaked as those beneath, and that without this thorough soaking the effects of the oil were soon lost. I had noticed other bamboos in the workshops which showed little traces of the oil although they had been through the complete process. In reply to my letter Mr. Williams agreed that it was possible that the upper bamboos in the oil tanks had not received a sufficient soaking. To make this point more certain I commenced the following further experiments on the 20th May:—

Experiment VIII.—A well oiled bamboo was put into a box and in with it were placed pieces of bamboo completely riddled by the shot-borer and full of living grubs, pupæ and beetles. I examined the box on the 24th and 26th May upon which dates the oil bamboo still remained unattacked.

Experiment IX.—*Experiment with bamboos in the open*—Bamboos in all stages of treatment were placed in close juxtaposition with badly infested bamboos as follows:—Lengths of untreated, water, $CuSo_4$ and oil-treated bamboos placed in a row upon a table and covered with split opened out segments of larger-diameter bamboos containing beetles and larvæ, etc.

On the 29th May I paid another visit to the works and found that a large number of the bamboos had been fitted and finished and were stacked in a covered shed open at one side. They were separated in lots by bamboo uprights. These latter had not been treated and were attracting the beetles. The bamboos were exposed to the rays of the hot afternoon sun. I examined the lots carefully and came to the conclusion that the oil treatment had been very uneven; some bamboos having evidently not been as well treated as others.

I could not find a single case of a well-soaked bamboo being attacked by the beetle although I examined a good many. This coincided with the experiments I was conducting at the Museum. I accordingly informed the Superintendent that I was of opinion that the oil treatment was effective if done thoroughly. I pointed out that the beetles had been so numerous during May that it was probable that few of the 9,000 bamboos (the number received for conversion into telegraph posts) would have remained unattacked had they not been treated in the manner described.

The following is a summary of the observations recorded for the second month of the experiment up to June 23rd:—

Experiment I.—Untreated bamboo—Beetles, both alive and dead, were found at the bottom of the box throughout the month, the number being large on June 23rd. Large amounts of saw-dust. Some predaceous beetles* (Pl. I, fig. 2) present feeding upon the boring beetles.

Experiment II.—Water—No signs of attack.

Experiment III.—$CuSo_4$—No signs of attack.

Experiment IV.—Oil—No signs of attack.

Experiment V.—$CuSo_4$—Numbers of beetles, both alive and dead, found at bottom of box, the number being largest on June 23rd. A very large amount of saw-dust has been excavated by the beetles and their larvæ. The greater bulk of a new generation of beetles is evidently issuing now (23rd June) from the bamboos. Parasitic beetles and ichneumon flies taken from the box but are not in sufficient numbers to act as an efficient check upon the pest.

Experiment VI.—Oil—No signs of attack.

Experiment VII.—Oil—No signs of attack.

Experiment VIII.—Oil and untreated attacked bamboo—Towards the beginning of the month noted that a beetle had endeavoured to bore into the oil bamboo. It had made a tiny shallow circular depression and then stopped work. Number of dead beetles lying in vicinity of the oil bamboo. A large number of living beetles in box on 23rd June.

Experiment IX.—Experiment with bamboos in the open—The untreated bamboos and the ones soaked in water and $CuSo_4$ were all attacked during the month by beetles from the infested pieces placed close to them, and on the 23rd June were being freshly riddled by the new generation of beetles then issuing. The oil bamboos although subjected to the same conditions as the others all remained unattacked.

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* *Thanasimus* sp.

Experiment X.—On the 15th June placed an untreated bamboo in a box with a pair of beetles in order to ascertain the number of eggs laid and the nature of the gallery bored. This latter is generally practically impossible owing to the beetles and larvæ working gregariously in the bamboo with the result that the tunnels all run into one another.

From the above summary it will be seen that at the end of the second month of the experiment all the bamboos which had gone through the whole process (Experiments IV, VI, VII, VIII, and IX) showed no attack by the beetles. Those which had been infested previously to the oil bath must have had all eggs, larvæ and beetles they may have contained at the time killed off by the oil. It may be contended that the beetles have in all cases had other bamboos to attack and so have left the oiled ones alone. Since, however, this will almost invariably be the case throughout the country, this point would not appear to be an important one.

For the third month up to July 27th the following results were obtained:—

Experiment I.—Untreated bamboo—A large number of beetles taken from the box this month, especially on and after July 21st. From the number found alive between July 21st and 27th it is probable that a new generation of beetles arising from the eggs laid by the June beetles issued at this period: a few predaceous beetles present.

Experiment II.—Water—No signs of attack.

Experiment III.—$CuSo_4$—No signs of attack.

Experiment IV.—Oil—No signs of attack.

Experiment V.—$CuSo_4$—A very large number of beetles taken from this box (mostly alive) towards the end of the month, as many as 106 being taken out on July 21st—evidently a new generation.

Experiment VI.—Oil—No signs of attack.

Experiment VII.—Oil—No signs of attack.

Experiment VIII.—Oil and untreated attacked bamboos—No signs of attacks. Beetles very numerous in the box and in the untreated bamboo.

Experiment IX.—Experiment with bamboos in the open—The attack has been continued in the untreated, water and $CuSo_4$ bamboos, and towards the end of the month a number of new holes were apparent, made by the new generation of beetles. In many cases these latter were watched boring into the bamboos. The paper wrappers tied round the bamboos (on which the number of the particular experiment, etc., was written) showed round holes through them, the result of fresh work on the beetles' part. Numerous beetles were also observed flying about the office between the 21st and 27th of the month.

The oil-treated bamboos were unattacked.

On the 29th June I received a communication from Mr. Williams in which he informed me that he had resoaked all the bamboos (by then mostly converted into field telegraph posts) in oil. Although this was perhaps scarcely necessary in the case of many yet as those in which the oil treatment was not satisfactory were mixed up with those which were fully soaked it was evidently the safest thing to do. On the 20th July I again paid a visit to the works and inspected the 9,000 bamboos. The Superintendent reported no further attack, and this is the case at the present date (18th August) although at least two generations of the beetles have issued since the treatment was carried out. Under the present plan of soaking, which I was shown during this visit, every bamboo remains well covered by the oil in the tanks for 24 hours before being removed.

For the fourth month up to 21st August the following results were obtained:—

Experiment I.—Untreated bamboo—During the first days of August beetles continued to issue freely from the bamboos. From then onwards only a few were obtained from the box. Heavy boring by grubs was, however, going on inside the bamboos.

Experiment II.—Water—No signs of attack.

Experiment III.—$CuSo_4$—No signs of attack.

Experiment IV.—Oil—No signs of attack.

Experiment V.—Beetles were still issuing freely at beginning of August and they commenced to do so again about the 21st. Predaceous beetles and ichneumon flies fairly numerous.

Experiment VI.—*Oil*—No signs of attack.

Experiment VII.—*Oil*—No signs of attack.

Experiment VIII.—*Oil and untreated attacked bamboos*—Oil bamboo unattacked.

Experiment IX.—*Bamboos in the open*—Beetles and larvæ plentiful in the untreated, water, and $CuSo_4$ bamboos. The oil-treated bamboos remained unattacked.

The prepared telegraph posts in the Workshops remained unattacked throughout the month.

For the fifth month up to September 28th the following results were recorded:—

Experiment I.—*Untreated bamboo*—Between August 21st and September 7th a large number of beetles issued from the bamboos and were found in the box—evidently a new generation. Again at the end of the month the number once more increased, 88 living and 63 dead beetles being taken from the box between September 22nd and 28th. This would be yet another generation—the period from egg to beetle of this one being evidently less than a month.

Experiment II.—*Water*—No signs of attack.

Experiment III.—*$CuSo_4$*—No signs of attack.

Experiment IV.—*Oil*—No signs of attack.

Experiment V.—*$CuSo_4$*—The generation of beetles which commenced to issue after August 21st continued to issue up to September 7th, as many as 130 beetles being obtained from the box.

Predaceous beetles feeding upon the bamboo-borers fairly numerous. The number of beetles issuing was less during latter part of the month. A large number of half-eaten remains of the shot-borers taken from the box.

Experiment VI.—*Oil*—No signs of attack.

Experiment VII.—*Oil*—No signs of attack.

Experiment VIII.—*Oil and untreated attacked bamboos*—Oil bamboo unattacked.

Experiment IX.—Bamboos in the open—Beetles issued during the first and latter part of the month freely from the untreated, water, and $CuSo_4$ treated bamboos. Of the oil bamboos, one which had not been thoroughly soaked was attacked by two beetles at one end. The other properly soaked oil bamboos remained unattacked.

The Superintendent reported at the end of the month that none of the prepared telegraph posts had been attacked.

For the sixth month up to October 30th the following observations were recorded:—

Experiment I.—Untreated bamboos—The generation of beetles which commenced to issue towards the end of September continued on into October, 150 beetles issuing between September 29th and October 7th. In the latter half of October beetles again issued numerously, over two hundred beetles issuing by the end of the month.

Experiment II.—Water—No signs of attack.

Experiment III.—$CuSo_4$—No signs of attack.

Experiment IV.—Oil—No signs of attack.

Experiment V.—$CuSo_4$—During the month the number of beetles issuing decreased until towards the end of the month the shot-borer beetles entirely stopped coming out. On the other hand, a number of predaceous beetles (both *Thanasimus* sp. and *Hectarthron brevifossum*, see Plate I, figs. 2 and 3) issued during the latter part of the month they having evidently got the upper hand and practically exterminated all that were left of the bamboo-borers.

Experiment VI.—Oil—No signs of attack.

Experiment VII.—Oil—No signs of attack.

Experiment VIII.—Oil and untreated bamboos—Oil bamboo is still unattacked.

Experiment IX.—During the first part of the month beetles issued in large numbers from the untreated, water, and $CuSo_4$ bamboos. During the latter part of the month a cold snap occurred between the 24th and 29th and this seems to have put an end to the beetle's work. Oil bamboos unattacked except the badly treated one in which boring continued to a slight extent throughout the month.

Plate II shows the condition of these bamboos at this period. No. 1 is the imperfectly oil treated one which was attacked; Nos. 2, 3 and 4 are untreated, water, and $CuSo_4$ treated, all attacked; No. 5 portion of the large infested opened out bamboo; No. 6 a fully oil-treated bamboo, unattacked.

I visited the Workshops during the month, and inspected the converted bamboos. I could find no signs of attack by the shot-borer although at least four generations of the beetle had issued in Calcutta since they had been treated.

For the seventh month up to the 15th November the observations recorded show that the attack of the beetle practically ceased this year at the end of October with the coming of the first cold snap. In warmer years the attacks would probably be carried on up to the middle of November.

Results.

The following deductions may I think be considered as established by the above experiments:—

(1) That neither the five days in water nor that followed by a further five days in $CuSo_4$ are of any use as a protection against the beetles. It is true that Experiments II and III seemed at first to prove that these soakings were effective since the bamboos in these boxes have remained unattacked. I attribute this, however, solely to the fact that the pieces of bamboos, selected at haphazard in the Telegraph Workshops, and placed in the closed boxes in April when the beetles were egg-laying, did not happen to have had egg deposited in them and consequently when they were placed in the beetle-proof boxes and protected against any future depositions of eggs in them they showed no attacks. All the subsequent experiments with these classes of treatment show that they afford no protection against the beetles.

(2) That the bamboos which had gone through all the stages of the treatment and had received a proper soaking in the oil tank remained unattacked and in addition were proof against further attacks by the beetles.

(3) That at least five generations of these beetles issued between the last week in April and the end of October: the 1st taking about seven weeks, from end of April to the third week in June, to run

through all its stages: the 2nd about 4-5 weeks, from the third week in June to near the end of July: the 3rd 4 weeks, from the end of July to the beginning of September: the 4th less than 4 weeks, from 1st week in September to end of the month: the 5th from end of September to end of October. It is probable that many of the beetles of this generation were caught and killed off by the cold snap experienced towards the end of the month.

(4) That bamboos cut in the forests between December and February can, even if not treated till two and three months have elapsed since cutting (by which time it is probable that many of them will contain eggs), be preserved by the oil treatment from further attacks of the beetle-borer. Bamboos unprotected by the oil treatment are tunnelled into by the April, June, July, September, and October generations of beetles, each of which attacks means their subsequent riddling by the larvæ arising from the eggs laid by the beetles.

(5) That the oil treatment therefore considerably prolongs the period of usefulness of the bamboo, this period being, as far as the experiments at present show, at least a year.

Recommendations.

(*a*) I am inclined to recommend that the soaking for five days in water should be continued since a thick shiny gelatinous substance exudes from the bamboos during this process, and this exudation probably enables the bamboo to absorb a larger quantity of oil than would be otherwise the case.

(*b*) That the soaking in the copper sulphate solution be discontinued since the experiments have shown it to have no preservative effect against the beetles.

(*c*) That the bamboos be allowed to dry in a covered shed for several days after the water process.

(*d*) That after drying the bamboos be soaked for 48 hours in common Rangoon oil.

Cost.

The Superintendent of the Telegraph Workshops informed me that the cost of the treatment as carried through by him, *i.e.*, five days in water, five days in $CuSo_4$ followed by several days drying and then two separate soakings (at an interval of a couple of months) of 24 hours each in Rangoon oil, amounted to R3-5 per 100 6-foot lengths or 6·3 pies per length. This includes the labour.

Omitting the $CuSo_4$ treatment and a second soaking in the oil, together with the additional handling involved, should effect a saving in this price, although of course the longer period of soaking in oil will enable the bamboos to absorb more of this commodity than they would in the shorter one of 24 hours only.

Concluding Remarks.

Although we have yet to see how long the oil-soaked bamboo will remain proof against the attacks of the beetles, I am of opinion that the experiments have advanced sufficiently to render the publication of a note upon the subject of use to those concerned. Bamboos are so largely used throughout the country that the prolongation of their period of usefulness by even a year only would effect a considerable monetary saving. I trust, however, to be able to show that the treatment will be found to have a yet longer beneficial effect. To the Director General of Telegraphs belongs the credit of having initiated this oil treatment, and to Mr. Williams, to whom my thanks are due for the courtesy with which he has aided me with the specimens and information required to carry on the series of experiments, that of having so efficiently carried it out.

Summary of Observations on the Treatment made in 1905.

The above described experiments were, as we have seen, carried out during 1903.

In 1905 a visit was paid to the Telegraph Workshops with the object of ascertaining how the treated bamboos which had been converted into telegraph posts had fared and especially how those which had been sent on service with the Tibet Expedition had faced the ordeal and in what condition they had returned.

At the Workshops I found that it was easy to trace the history of the bamboos treated in 1903, all of which had been converted into field telegraph posts, a stage further in their career.

The evidence collected both in the use of the posts in the field and, equally important, by their storage in an open shed without any special protection being afforded to them in the Workshop yard in Calcutta points to the wonderful efficacy of the oil treatment. It is the purpose of this supplementary note to give publicity to this fact. Firstly, owing to numerous enquiries having been received from the Public Works Department as to the necessary treatment to be given to bamboos in order to ensure their longevity, and secondly, because the oil treatment for the preservation of bamboos may be said to have now passed the rubicon of the 'Experimental Stage' and to have reached the arena of practical utility.

To go back to the bamboos converted in 1903. Some of them were sent up that year for service with the Tibet Mission. They were returned to store in Calcutta about the beginning of 1905, and Mr. L. Truniger, C.I.E., who was in charge of the Field Telegraph with the Mission, has stated that they had fully answered expectations. Some of these returned posts were inspected by the writer in the yard at Calcutta towards the end of March 1905. Although it was two and a half years since they were cut in the forests of Upper India and close upon two years since they were treated with the oil, they showed no trace of attacks by the Dinoderus bamboo beetle. It may be contended, and justly, that throughout 1904 these posts had been at an altitude greatly above that at which either of the shot-borer beetles could, or do, live and that they were thus safe from their attacks. This was so, but the same argument does not hold good when we come to consider those converted bamboos which remained throughout the year in store in Calcutta. An inspection of these has shown that they have remained equally immune from the pest. Most are aware how short is the life, economically, of the bamboo after it has been cut. To the Public Works, Military Works, Forest Department, and many other minor departments it means a constantly recurring annual expenditure on petty works; and many also know the difficulties which stand in the path of the lance, the tent-pegging and hog spear purveyor. The results that have attended the treatment of the 9,000 bamboos in 1903 are well worthy of the consideration of all of these, for on present observations it has been shown that the impregnation with the oil leaves the bamboo strong and serviceable two and a half years after it has been cut. Arrangements have been made to keep some of these bamboo telegraph posts under continuous observation

The Treated Bamboos in 1909.

In reply to a reference on the subject the Superintendent of the Telegraph Workshops wrote as follows on the 20th September 1909:—

"In 1904 some 15,000 posts were made (*i.e.*, soaked in water and Rangoon oil), the majority of which were afterwards stored in a heap in an open shed in this yard until quite recently. It was found that wiping them over once a year with earth oil gave absolute protection from the borer."

Now the yard in which these bamboos are stacked may be said to be situated in the heart of an area infested by the beetle borers. In the neighbourhood are native depôts containing hundreds of thousands of bamboos in which the beetles are to be found in millions.

I think no further argument in favour of the enormous value and efficacy of the water and oil treatment can be required than is afforded by these 15,000 bamboos which have remained immune to the beetle-attacks for a period of five years and are as good and sound to-day as they were when they were treated.

PLATE I.

Bamboos tunnelled into by the Bamboo borer (*Dinoderus minutus*). 1—4, ordinary small bamboo; 5, length of a large bamboo opened out flat to show the attacks of the beetles and their grubs; 6, portion of a bamboo which has been subjected to the oil treatment and has subsequently remained immune to the attacks of the insects.

PLATE II.

FIG. 1. *Dinoderus binutus.* The bamboo beetle borer—a, larva; b, pupa; c, dorsal and side view of beetle; d, length of bamboo showing entrance holes on the outer surface and the manner in which the interior is riddled by the insects.

FIG. 2. *Thanasimus* sp. A beetle which follows the bamboo beetle into its tunnels and devours it there.

FIG. 3. *Hectarthron brevifossum.* A beetle which feeds upon the bamboo beetle in its tunnels.

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with the object of ascertaining the longevity to which the treatment enables them to attain. That the Telegraph Department has the fullest confidence in a discovery the full credit of which chiefly belongs to it, is borne out by the fact that an additional 30,000 bamboos were put through the treatment and converted into field telegraph posts in 1905. It may be stated that the recommendations of the previous note are being followed, the bamboos being first soaked in water for five days (this is very necessary for reasons previously given), allowed to dry for several days, and then resoaked in the Rangoon oil (crude petroleum), this latter, as used in the Workshops, having the consistency of treacle.

That the use of the bamboo as a field telegraph and telephone post has a great future before it has been proved by the Japanese in the present campaign. The following note upon the subject appeared recently in the *Pioneer:* "Every general of brigade in the field is 'at the end of a wire' which his divisional commander controls and the generals of divisions are in touch by telegraph or telephone with the corps commander. The engineers run wires after the columns with marvellous rapidity. Firing is heard somewhere at the front. A detachment of engineers emerges from head quarters, pack ponies carrying bundles of light bamboo poles, while coolies and carts follow them with coils of slender copper wire. The poles, which have pointed ends, are quickly planted, the wire spreads out as fast as men can uncoil it, and a field telephone is at work." As having a bearing upon the experiments and results attained in India, Mr. Y. Hara, Chief of the Japanese Forest Bureau, was addressed with the object of ascertaining whether the bamboo field posts used by his countrymen were subjected to any treatment. His reply would seem to show that in this matter Japan is in the position occupied by India before the discovery of the oil treatment. He wrote: "In answer to your enquiries with regard to a protection of our bamboos, I would state that although the method in preserving bamboos in the field is not well known, there are three processes of treatment generally adopted by our people—

(1) The season of cutting—September and October.

(2) The fumigation in sulphur.

(3) Application of both of these processes."

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NOTE ON BEST SEASON FOR COPPICE FELLINGS OF TEAK (TECTONA GRANDIS)

BY

R. S. HOLE, I.F.S., F.C.H., F.L.S., F.E.S.
Imperial Forest Botanist

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NOTE ON BEST SEASON FOR COPPICE FELLINGS OF TEAK (TECTONA GRANDIS)

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R. S. HOLE, I.F.S., F.C.H., F.L.S., F.E.S.,
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NOTE ON

BEST SEASON FOR COPPICE FELLINGS OF TEAK (TECTONA GRANDIS).

Desirability of carrying out removal of Forest Produce when Labour easily obtainable locally.

(1) Purchasers of forest produce, other things being equal, usually prefer to collect and remove that produce at seasons when labour is most easily obtainable locally, and if their work is restricted to periods when they find great difficulty in obtaining labour the natural result is a fall in prices of forest produce and a diminished forest revenue.

Prejudice in favour of felling timber in rainy season.

In many parts of India the latter part of the rainy season from the middle of August to October is a favourite season for felling timber, partly on account of this being in many districts a season of comparatively slight agricultural activity, the sowings of the rainy season crops having been completed and harvest having not then commenced, and also partly on account of a very widespread belief that wood cut during the rainy season is more durable than that cut at any other time of year.

Question arising in the Central Provinces as to the advisability of stopping all fellings in the rains.

(2) In and about the year 1898, considerable attention was paid by Forest Officers in the Central Provinces to the following points:—

(*a*) The rainy season is the period of maximum vegetative activity for the majority of the important species in the local deciduous forests.

(*b*) Reproduction by seed in such forests is usually deficient and the maintenance of the forests depends, to a considerable extent, on so-called coppice reproduction; (considered in the ordinary sense as reproduction by means of shoots springing from the stool, or roots, or both, of the felled mother trees, apart from any consideration as to what extent this can be regarded as true reproduction by means of a division of the mother plant).

(c) That unless there is a sufficiency of reserve food materials in the stool and roots, a vigorous development of coppice shoots is impossible.

(d) That the quantity of such reserves is usually assumed to be greatest during the period of vegetative rest and least during the period of vegetative activity and that, consequently, on theoretical grounds, felling during the rains must be highly detrimental to coppice reproduction and should not be allowed.

The absence of any definite statistics to approximately indicate the extent of the damage which might be caused by felling in the rains, made it very difficult to decide how far the maintenance of the forest necessitated interference with existing custom and a diminished revenue. There was, therefore, room for considerable difference of opinion on this point, and while one Conservator considered that he was "completely justified in stopping it (*i.e.* felling during the rainy season) altogether" another Conservator noted that "it will be time enough, I think, to interfere with all former practice when we have some exact data on the matter."

Experiments started in the Central Provinces to determine the effect of the season of felling on coppice reproduction.

(3) Dating from this period, a number of experimental coppice plots were established in the Central Provinces with the object of obtaining some reliable data, in the case of the more important species, as to the injurious effect of cutting back at certain seasons on coppice reproduction.

The history of these experiments in the Central Provinces is instructive, being on the whole similar to that of many others, dealing with other subjects in different localities.

The season of felling may for our purposes be regarded as a single factor, but in addition to it there are many others such as the method of cutting, age and vigour of the mother tree, quality of the soil, amount of available light and so on, each of which is probably capable of affecting coppice reproduction to an equal extent and possibly to an even greater extent than is the particular factor which we have selected for study.

If care is not taken to eliminate such factors from our experiments, it is obvious that we cannot possibly say with certainty whether an observed result, in the way of inferior coppice reproduction, is due to the factor we are trying to study, *i.e.* the season of felling, or to any of a number of other factors. No definite results can possibly be obtained from such experiments which must accordingly be considered failures.

The elimination of the necessary factors is in many cases undoubtedly a matter of great difficulty, but much can be done in this way and the results obtained from any forest experiment will, as a rule, be directly proportional to the amount of care which has been taken to eliminate all necessary factors which can be eliminated and to keep all others constant, with the single exception of that factor the effect of which it is desired to measure and which is of course allowed to vary.

Insufficient appreciation of the difficulties experienced in practically arranging a field experiment on these lines is the cause of the common idea that several objects can be combined in one and the same experiment, and that we can for instance deal at the same time not only with the effect of the season of felling, but also with several other factors such as the influence of different types of soil on the coppicing capacity of several different species and so on.

In the case of the present experiments also, in order to get the work started as quickly and on as large a scale as was considered desirable by the authorities, the Divisional Forest Officer himself had in most cases no time to personally select the experimental areas and this work, on which the success of the whole experiment depended, was usually carried out by subordinates.

Each of the experimental areas selected consisted of several small plots of forest, a single plot being felled each month for a fixed number of months. Annual measurements of the heights of the resulting coppice shoots in these plots were prescribed for a period of years, these measurements to be carried out in January of each year, and it was hoped that a comparison of the figures thus obtained would give reliable data regarding the effect of felling at different seasons.

Experiments generally unsuccessful.

The following are a few examples of the causes which prevented any useful results being obtained from most of the experimental areas :—

(*a*) Some of the plots of the experimental area were situated in a so-called "frost-hole" where the coppice shoots were killed down annually by frost, or on soil which was of greatly inferior quality to the rest of the area.

(*b*) Although, in the attempt to obtain as extensive results as possible, an area had been selected which contained several different species, no single one of these occurred in sufficient numbers in all the plots of the area to make a fair comparison possible between them, and thus between the result of fellings at different seasons. Instead, therefore, of obtaining useful data for a number of species, the experiment failed to deal satisfactorily with a single one.

(*c*) In some plots of the experimental area some exceptionally fine trees had been spared and left as standards when the rest of the trees were cut, the resulting coppice growth being in consequence exposed to very varying conditions of light in the different plots, which effectually obscured any effect which the season of felling might have had.

Scope of present paper.

(4) In the present paper it is proposed—

(1) to give the results obtained up to date in a single experimental area selected in Block 46 of the Jubbulpore Range, Jubbulpore Forest Division in 1906, when the writer held charge of the Division and which was visited by him in 1908 in connection with research work on the reproduction of teak. He was then able to personally check the accuracy of a large number of the observations which had been recorded, and he has recently had an opportunity of working up the figures obtained. This experiment has been carefully conducted and has furnished results of considerable interest, and

(2) with the object of making future experiments more valuable than those which have been carried out hitherto, to give a few suggestions regarding the procedure which might with advantage be adopted in such experiments. The adoption of these suggestions will also tend to secure uniformity of procedure which will greatly facilitate the comparison of the results obtained.

Experimental Plot started in the Jubbulpore Division, in 1906.

(5) The experiment under report was commenced in the Jubbulpore Division, Central Provinces, in 1906. It proposed to deal with a single species *viz.* teak (*Tectona grandis*) and to discover what effect felling at different seasons during the period March to September inclusive would have on the resulting coppice growth.

It was realized at the outset that the vigour of the coppice growth must, to a great extent, depend on the vigour of the mother trees. It was also considered that trees of approximately the same girth and height might be considered to be of similar vigour for the purposes of the experiment.*

Selection of Experimental Area.

As it was proposed to cut over one plot in each month during the period March-September inclusive, 7 plots in all were required. Further, it was considered that at least 20 teak trees of similar girth and height should occur in each of the 7 plots in order to give a fair average result. Although the height of the trees on the area would give some idea of the character of the factors of the locality, it was considered necessary to avoid as far as possible all variations in any such factors and to see that the conditions of geological formation, soil, elevation, aspect and configuration should be as similar as possible throughout the area. It was also essential that the experimental area should not be exposed to damage by frost or fire and that it should be effectually protected from damage by deer and cattle. The selection of a sufficient area of homogeneous forest satisfying the above conditions, containing the necessary number of teak, and in a situation accessible at all seasons, was no easy matter in the irregular teak forests of the Jubbulpore Division, but a fairly satisfactory area was eventually demarcated and divided into 7 plots in Block 46 (coupe 21) of the Jubbulpore Range on the top of the hill named Nau Kol, Lat. N. 23°7′—23°12′, Long. E. 80°-80°8′.

Description of Plot and Local Conditions.

(6) The area selected was fairly typical of many of the inferior teak forests widely distributed in the Central Provinces and which extend to other parts of the Peninsula. Teak was the dominant species and associated with it were *Anogeissus latifolia, Ougeinia dalbergioides, Lagerstrœmia parviflora, Diospyros tomentosa, Nyctanthes Arbor-tristis* and others. The cover was close with no grass on the ground. None of the teak exceeded 50′ in height and they showed an average height and basal girth of about 38′ and 3′ respectively. The majority of the trees were unsound at the base and, as is the case in most of the local forests, showed signs of damage done in the days previous to systematic forest management by irregular cutting and pollarding.

The area was approximately level with a very slight slope towards the North.

The geological formation was trap throughout, and the soil a heavy loam, the upper 1′—1½′ coloured red, and turning yellow below with an increasing proportion of basalt boulders down to practical rock at 3′6″.

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* See also paragraph 9 below.

Approximate elevation above sea-level =1560′.

The average annual rainfall in the neighbourhood of the area is about 64″ mostly received during the S. W. monsoon from June-October. The rain usually commences in the latter half of June with the heaviest falls in July and August. The cold season may be said to extend from the middle of October to middle of March, and the hot season from middle of March to middle of June. The local forests belong to the great class of the deciduous Indian forests in which several species put out their young foliage and come into full vegetative activity early in the hot season, long before the break of the monsoon, but the teak, with the majority of its associates, is later in this respect, and although in damp places in the locality under consideration the young leaves may be seen appearing in May, they do so as a rule in June and the full foliage is not developed until the rains have well set in, usually in July.

The period of maximum vegetative activity is from July to September but the leaves usually remain on the trees from November to December, and in damp places for some time longer. The flowers usually appear in August-September and the fruit ripens November-January.

It is important to note that the actual date of the appearance of the young leaves and of the commencement of vegetative activity depends, to some extent, on the dates of occurrence of local showers during the hot season.

In 1906, the year in which this experiment was initiated, several teak were seen in the Jubbulpore forests with their young leaves appearing in April, quite a month earlier than usual, and the same thing was noticed in the case of several other species. This was ascribed to the occurrence of unusually frequent showers in the preceding February and March. It was also then noticed that the smaller teak trees, as a general rule, were earlier in this respect than the older trees.

Conduct of Experiment.

(7) The experimental area was first divided into 7 plots so that each plot should contain approximately the same number of teak trees of equal vigour, and the boundaries of the plots were laid down with lines of boulders. A straight base line was then laid out through the centre of the area and defined by means of a trench and a line of boulders. Each tree to be included in the experiment was given a number and its position fixed by 2 measurements, (1) the length of the offset from base line to the tree, (2) the length from foot of offset to one end of the base line. These measurements were recorded in a register and, in addition, a map was prepared of the area showing the position

of each tree. The plots were numbered I to VII inclusive and were felled on the following dates:—

Plot No. I on March 20th, 1906.
„ „ II „ April „ „
„ „ III „ May „ „
„ „ IV „ June „ „
„ „ V „ July „ „
„ „ VI „ August „ „
„ „ VII „ September „ „

The areas of the respective plots and the number of teak trees considered suitable for the experiment which were included in each are as follows:—

Plot.	Area in Acres.	No. of Teak Trees.
I	0·25	20
II	0·25	22
III	0·25	23
IV	0·32	21
V	0·25	23
VI	0·25	22
VII	0·25	21
		152

To insure the stools in all the plots being exposed as far as possible to similar conditions of light every stem standing on each plot, irrespective of whether it was registered or not, was cut, all the timber, branches and debris were carefully removed from the plot and an external boundary line 30′ wide was gradually cleared around the entire area *pari passu* with the plots in order to avoid the injurious effect of side shade from the surrounding forest.

In order that any differences in the coppice growth might not be ascribed to the way in which the trees were cut, or the stools dressed, the method of felling adopted was the same throughout, all stems being as far as possible cut flush with the ground and the stools being given a flat surface.

The number of each tree included in the experiment was painted on the stool. A tin label bearing the number was also affixed to a stake and driven into the ground by the side of the stool.

At the time of felling, the height of each tree cut was measured and noted in the register opposite the serial number concerned and also the average diameter of the stool.

The whole area was carefully fenced to protect the young shoots from damage by deer.

The coppice shoots springing from each stool were then carefully measured once annually at the beginning of January, *i.e.*, at a period when vegetative activity had practically ceased.

The present paper deals with the measurements and observations recorded in 1907 and 1908.

Factors to be employed as criteria of the success of coppice reproduction.

(8) As regards the factors to be employed as criteria of the success or otherwise of coppice reproduction the following are probably of most value:—

(*a*) The number of stools which die and fail to produce any coppice shoots at all.

(*b*) The height growth of the leading shoot on each stool.

(*c*) The average number of vigorous, or dominant, shoots per stool, the majority of which may be expected to survive and form the stems of the future, while all of them are probably capable of satisfactorily taking the place of the leader if the latter is injured or destroyed.

The last factor is of importance not only because the yield of an area of coppice to a certain extent depends upon it, but also on account of the possible effect which the number of vigorous shoots on the stool may have upon the height growth of the leading shoot. A stool also which bears several shoots each one of which, in case the leader is damaged or destroyed, is capable of taking the place of the leading shoot, is obviously superior in some respects to a stool with only 1 or 2 vigorous shoots.

It is of course impossible, during the first year or two of coppice growth, to select with certainty the shoots which will survive and form the stems of the future, and an arbitrary definition of a dominant shoot must therefore be accepted. In this connection it must be remembered that coppice shoots, although of vigorous growth as regards their dimensions and other respects, are frequently prostrate instead of being erect and such shoots clearly cannot be classed as dominant. In this paper, therefore, all shoots on a stool which are erect and not less than half the height of the leading shoot have been considered dominant.

The number of stools available for comparison in the present experiment have not been sufficient to warrant any conclusion regarding the competitive action of the dominant shoots of a stool on one another. Three comparisons comprising 18 stools of class II*, similar in all respects except in the number of their dominant shoots, have all shown that the height growth during the first year of the leading shoot is slightly greater on stools with 2 dominant shoots than on stools with 3 such shoots, but that this difference diminishes in the 2nd year. In the case of class III* stools the comparisons which have been possible indicate that the height of the leader, at all events during the first 2 years, is independent of the number of vigorous shoots. The competitive action probably depends largely on the position of the shoots on the stool, on the position of the old roots of the mother tree and on the extent to which adventitious roots are developed at and near the base of the young shoots. If the shoots on a stool are widely separated from each other and each of them has a number of vigorous roots in its immediate neighbourhood, they are probably more or less independent and are not likely to seriously interfere with each other's development, at all events during the first year or two.

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* See paragraph 9 below.

It has been suggested that by thinning out the vigorous shoots on a stool and by only allowing one, or perhaps two, shoots to develop the quality of the latter may be improved owing to the reduced competition.

Even if such thinnings do result, as in some cases they may, in increasing the rapidity of early growth of the shoots which remain, such rapid growth probably means a larger pith and wood of less density and may thus, although increasing the quantity, actually reduce the quality of the wood.

It is highly desirable that experiments should be carried out with our important Indian species to test the effect of such thinnings, and in such experiments care should be taken to see that, before the thinnings are commenced, the stools to be compared are as similar as possible regarding their vigour, the average number of vigorous shoots per stool, the size and situation of such shoots, and other characters, while the factors of the locality are kept the same throughout.

. Care should be taken also to note the effect of such thinnings, not only on the dimensions of the leading shoots but also on the total volume of wood produced by all the shoots on the stools.

The total number of all shoots developed on a stool irrespective of their size and vigour is a criterion of comparatively little value, for minute shoots which are incapable of vigorous development are of no value to the Forester, and their effect on the height growth of the leader must as a rule be negligible.

Selection of suitable trees for comparison.

(9) As mentioned in paragraph 5 above, care was taken when selecting the experimental area to see that, so far as possible, the trees included in each plot were of equal vigour. At the

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* See paragraph 9 below.

same time as no actual measurements were taken until after the plots had been demarcated and felled this could only be done approximately. In the case of two mother trees which from their growth and dimensions are clearly seen to differ greatly in vigour we are obviously not justified in considering that the stools possess equal powers of coppice reproduction, and before comparing the figures recorded in this experiment regarding the coppice growth it is essential that we should select for comparison only those individuals of approximately equal vigour. Trees which at the same age show approximately equal girth and height growth may for the purposes of this experiment be considered of equal vigour, these dimensions being the net result of the balance struck between the innate vigour of the individual and the factors of the locality, such as quality of soil, amount of available moisture and so on, to the influence of which the individual is exposed.

In the present case owing to the damage done by irregular cutting and pollarding, the majority of the trees showed very irregular growth at the base with more or less unsoundness. As it was thus impossible to count the annual rings, the basal girth, or diameter, had to be taken as an approximate indication of the age. The trees registered were then found to fall into the following classes :—

Class I	Basal	Diameter*	4"— 8".	Approximate	girth	1'—2'	8 trees.
,, II	,,	,,	8"—12"	,,	,,	2'—3'	67 ,,
,, III	,,	,,	12"—16"	,,	,,	3'—4'	54 ,,
,, IV	,,	,,	16"—20"	,,	,,	4'—5'	21 ,,
,, V	,,	,,	20"—24"	,,	,,	5'—6'	2 ,,
						TOTAL .	152

As trees of Classes I and V did not occur in all the plots, and as only one or two trees of Class IV occurred in several plots, all trees belonging to these classes were first excluded from the experiment, as an average result regarding them could not possibly be obtained from such small numbers.

Of the 121 remaining trees in Classes II and III, 93, or 77 per cent., showed the following average height :—

Class II, average height 35' (from 30'—40')
,, III ,, ,, 40' (from 35'—45')

The 28 trees belonging to these classes the height of which was either less than, or in excess of, the above, were considered to be exceptional as regards their vigour and were excluded from the experiment. The results obtained in the present experiment from these 93 trees will now be considered in detail below.

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* These figures represent the mean diameters as measured at the cut surface of the stool.

Results of Experiment as judged by number of stools which died.

(10) Taking first the factor of the number of stools which died the plots compare as follows :—

Number of Plot.	I	II	III	IV	V	VI	VII
Date of Felling.	20th March.	20th April.	20th May.	20th June.	20th July.	20th August.	20th September.
Percentage of stools which died :— Of Class II	(a) *Nil*	11 per cent.	20 per cent.	(a) *Nil*	(a) *Nil*	*Nil*	(a) *Nil*
„ III	*Nil*	(a) *Nil*	(a) *Nil*	11 per cent.	25 per cent.	*Nil*	*Nil*
Percentage of failures calculated on the total stools of Classes II and III together.	*Nil*	7 per cent.	7 per cent.	6 per cent.	7 per cent.	*Nil*	*Nil*

(a) In addition to the actual failures the following percentage of stools only produced shoots of abnormally poor vigour. In the case of these stools all the shoots were prostrate instead of being erect, or else the leading shoots in each case showed less than half the height growth of the tallest leading shoot in the class. Such stools have been omitted from the results given in paragraphs 11 and 12 below but have been included as partial failures in paragraph 13 :—

in Plot I stools of Class II . . . . . 12 per cent. giving 9 per cent. for whole Plot.
„ II „ „ III . . . . . 20 „ „ 7 „ „ „ „
„ III „ „ III . . . . . 11 „ „ 7 „ „ „ „
„ IV „ „ II . . . . . 11 „ „ 6 „ „ „ „
„ V „ „ II . . . . . 10 „ „ 7 „ „ „ „
„ VII „ „ II . . . . . 14 „ „ 10 „ „ „ „

No stools, therefore, died which were cut in March. August and September, and the actual failures were confined to those stools cut in April-July inclusive. A reference to paragraph 6 above will show that in 1906, the year when the fellings were carried out vegetative activity commenced in this locality for the teak in April, about a month earlier than usual and also that as a rule the smaller trees were seen to produce young foliage first. The total failures are thus seen to be confined to a period extending from the commencement of vegetative activity up to the time when the foliage is fully developed, *i.e.* just when the transport of reserve food materials to the growing root-tips, buds and leaves, is in progress and when we should expect the store of reserves in the stool to be at the lowest ebb, whereas, felling before vegetative activity begins and again after the foliage has been fully developed for about 2 months and has probably been able to replenish the depleted reserves gives no total failure. In connection with the observation that in this locality the smaller trees were seen to come into leaf first, it is remarkable that during April and May the total failures were confined to the smaller Class II trees, and during June and July to the larger Class III trees. It is also noticeable that in Class II more failures occurred in May than in April and that in Class III more failures occurred in July than in June, possibly indicating that in each class a few trees are exceptionally early and that the bulk commence activity later.

Results of experiment as judged by the number of vigorous shoots per stool.

(11) Considering next the number of vigorous or dominant erect shoots developed per stool the plots compare as below. The dominant shoots have been selected according to the heights recorded in January 1908, *i.e.* when no shoot had enjoyed less than one complete season of vegetative activity :—

Number of Plot.	I	II	III	IV	V	VI	VII
Date of Felling.	20th March.	20th April.	20th May.	20th June.	20th July.	20th August.	20th September.
Average number of vigorous shoots per stool— in Class II .	1·7	2·0	1·8	1·6	1·9	1·6	2·4
„ III .	4·0	3·8	2·5	2·1	2·0	2·2	2·7
Average number of vigorous shoots per stool calculated on all stools of Classes II and III together.	2·3	2·6	2·3	1·9	1·9	2·0	2·5

With regard to this factor, therefore, there is no very marked difference between the plots, but those felled in March, April, May and September do show the best results.

It will be noticed that in all plots the number of vigorous shoots per stool is greater in the case of the larger Class III stools, and the number of such shoots therefore increases with the size and age of the stool, at all events up to a mean basal diameter of 16″.

Results of experiment as judged by height growth of leader.

(12) Lastly, considering the height growth of the leading shoots, the results are as follows:—

Number of Plot.	I	II	III	IV	V	VI	VII
Date of Felling.	20th March.	20th April.	20th May.	20th June.	20th July.	20th August.	20th September.
Average height of leading shoots measured in January 1907—							
For stools of Class II.	5′ 10″	5′ 4″	5′ 11″*	5′ 6″	2′ 8″	1′ 10″	0′ 8″
Do. III	8′ 3″	6′ 2″	5′ 7″	4′ 10″	3′ 0″	2′ 3″	1′ 2″
Average height for all stools of Classes II and III together in January 1907, produced in growing season of 1906	6′ 5″	5′ 7″	5′ 8″	5′ 2″	2′ 9″	2′ 0″	0′ 10″
Average height of leading shoots measured in January 1908—							
For stools of Class II.	12′ 10″	13′ 1″	14′ 3″*	12′ 10″	9′ 2″	7′ 10″	9′ 5″
Do. III	15′ 6″	13′ 10″	13′ 8″	12′ 4″	10′ 8″	9′ 7″	11′ 0″
Average height for all stools of Classes II and III in January 1908, produced in growing season of 1906 and 1907.	13′ 5″	13′ 4″	13′ 11″	12′ 7″	9′ 7″	8′ 9″	9′ 11″
Height produced in growing season of 1907 alone.	7′ 0″	7′ 9″	8′ 3″	7′ 5″	6′ 10″	6′ 9″	9′ 1″

* The height for Class II, Plot III, is possibly too great as compared with that in Plots I, II and IV owing to there being only 4 stools of this class in Plot III as compared with a minimum of 7 stools in the other plots. A larger number of stools would possibly have shown the height for Class II less than for Class III.

In considering these figures the first point to bear in mind is that we are dealing with shoots of *different ages*, and that a shoot which has only had the advantage of a portion of one growing season will necessarily show less height growth than a shoot which has enjoyed an entire growing season, although it may be actually a better shoot and capable of more vigorous future development.

From this point of view Plot VII shows the best height growth. During the first season the shoots had about ⅙th of the period of vigorous vegetative activity available in which growth was possible, and an average height of 0'10" resulted. The height growth put on during the 2nd growing season alone, however, 9'1", is superior to that put on in any other plot either during the 1st or 2nd season.

Assuming the height growth of this plot to have been as vigorous as that in Plot I also, we may put its estimated height in January 1908, at the first season's growth of Plot I + $\frac{1}{9}$th of the second season's growth $= 6'\ 5'' + \frac{1}{9}$th $(7') = 6'\ 5'' + 9'' = 7'\ 2''$ whereas, the actual height measured is far superior to this, *viz.* 8' 11".

Similarly, the height growth shown by Plot VI appears to be only slightly inferior to that of Plot I. During the first season the shoots of Plot VI had the advantage of only $\frac{4}{9}$th of the period during which vigorous growth was possible, hence, in January 1908, the shoots may be said to have had $1\frac{4}{9}$ seasons of growth. We may therefore calculate the normal height for this plot from that of Plot I, assuming that the difference of growth is due merely to a difference in the time available for growth and not to any injurious effect of the season of felling on the vigour of the shoot, by taking the first season's growth and $\frac{4}{9}$ths of the 2nd season's growth of Plot I, *i.e.* $6'\ 5'' + \frac{4}{9}\ (7') = 9'\ 6''$, whereas the actual height measured in Plot VI in January 1908 is 8' 9".

Similarly, we may consider the shoots of Plot V to have had $1\frac{7}{9}$ seasons of growth by January 1908 and the normal height may be calculated as $6'5'' + \frac{7}{9}\ (7') = 11'\ 10''$, whereas the height actually measured is 9'7", so that here the season of felling appears to have had an injurious effect manifested in the obviously less vigorous early growth of the leading shoot. The slight difference existing between the heights of Plots I and IV at the end of the first season are practically equalised during the second season and so far as height growth is concerned, Plots I-IV inclusive are practically equal.

This factor then shows the best results in Plot VII, while the only Plot which shows obviously inferior vigour due to the season of felling is Plot V. Even in Plot V the inferiority in height growth will very probably be made good in subsequent years, but a season of felling which results in producing shoots of obviously inferior vigour compared with those resulting from felling at other seasons is clearly to be avoided if possible. It should be noticed that all the stools for which height growth comparisons have been made, in all the plots, produced shoots during the first season.

Incidentally it will be noticed that stools of Class III generally show a greater early height growth of leader than stools of Class II and, in paragraph 11 above, it was noted that the number of vigorous shoots per stool was also generally greater in the case of the larger stools. Both the number of vigorous shoots per stool and the early height growth of the leader, therefore, increase with the size of the stool and the age of the tree at all events up to a basal girth of 4′. Observations elsewhere show that with very old stools both the number of vigorous shoots per stool and the early height growth again diminishes. The shoots then produced, however, are frequently well provided with independent roots while the slower early growth gives denser wood and on the whole such shoots, together with shoots developed from small stools which resemble them as regards the rapidity of growth, are probably the best.

Summary of results of experiment.

(13) As regards the effects of the season of felling therefore the results of this experiment may be summarised as follows:—

Number of Plot.	I	II	III	IV	V	VI	VII
Date of Felling.	20th March.	20th April.	20th May.	20th June.	20th July.	20th August.	20th September.
Percentage of total failures.	*Nil*	7 per cent.	7 per cent.	6 per cent.	7 per cent.	*Nil*	*Nil*
Percentage of partial failures.	9 per cent.	7 per cent.	7 per cent.	6 per cent.	7 per cent.	*Nil*	10 per cent.
Average number of vigorous shoots per stool.	2·3	2·6	2·3	1·9	1·9	2	2·5
Average height of leading shoots measured in January 1908, produced in growing seasons of 1906 and 1907.	13′ 5″	13′ 4″	13′ 11″	12′ 7″	9′ 7″	8′ 9″	9′ 11″
Estimated height of leading shoots in January 1908, assuming the vigour of growth to be equal to that of Plot I.	...	...	...	...	11′ 10″	9′ 6″	7′ 2″

The months which give the worst results therefore are as under.

Factor.	Months giving the worst results.				
Total and partial failures	April	May	June	July	...
Number of dominant shoots	...	...	June	July	August
Height growth	...	...	...	July	August
The worst months therefore are	April × 1	May × 1	June × 2	July × 3	August × 2

The months giving the best results are thus March and September.

Best Season for Felling.

On the whole then this experiment clearly indicates that, of the six months period dealt with, the worst period for teak coppice fellings is from the time vegetative activity commences up to, and for a short time after, the full development of the foliage; that the best season is immediately before and after this period.

Elimination of other Factors.

(14) Before finally accepting the above results as showing the effect of the season of felling on the coppice reproduction, it is necessary first to consider whether they may not be possibly ascribed to some other factor, the entire elimination of which was not possible in the circumstances under which the experiment was carried out.

Vigour of mother trees.

The first possible factor is the vigour of the mother trees. An attempt has been made to eliminate this factor by forming two classes as described above according to the vigour of the mother trees, in such a way that each class includes only individuals of approximately the same vigour. We should, therefore, not accept the figures given in paragraph 13 above, which are calculated in each case for the entire Plot and not for Classes II and III separately, unless it can be shown that the results taken separately for each class are in general agreement with those obtained for the whole Plot. Referring, therefore, to the figures given in paragraphs 10, 11 and 12 we get the following results for each class separately for the different factors:—

Factor.	Class.	Months giving the worst results.
Failures (total and partial taken together).	II	May.
	III	April, July.
Number of vigorous shoots per stool.	II	June, August.
	III	June, July, August.
Height of leading shoots	II	July the worst. August poor.
	III	

Taking all these factors together, therefore, we get for each class separately the worst results in the following months:—

For Class II.—May, June, July, August.

„ „ III.—April, June, July, August.

These two results, therefore, *both* agree in showing March and September as the best months which is in accordance with the conclusion arrived at in paragraph 13 from the figures which take Classes II and III together instead of separately.

Another point is that in certain Plots, in one and the same class, there may be a preponderance of more vigorous individuals which might vitiate the results obtained.

The average height growth of the mother trees included in the experiment however is as shown below for each Plot:—

Plot.	I	II	III	IV	V	VI	VII
Average height of mother trees.	35′ 3″	35′ 4″	36′ 9″	37′ 2″	36′ 3″	38′ 1″	35′ 10″

This shows that, excluding the April Plot, the *least vigorous* mother trees were in the March and September Plots, which clearly proves that the good results obtained in these two Plots cannot be ascribed to a preponderance of more vigorous individuals in those plots.

In any case also the differences between the Plots in this respect is very slight.

Soundness of Stools.

The next point of importance is the soundness of the stool. As noted in paragraph 6, the majority of the trees were unsound at the base and it was therefore unfortunately impossible to include in the experiment only those stools which were of approximately the same degree of soundness, as would have been desirable.

Every stool of the trees to be compared was carefully examined and the degree of the unsoundness noted. Those stools which showed considerable unsoundness in the centre, or in which the unsoundness extended to and included some of the margin of the stool, were classed as unsound and the remainder were considered sound.

The proportion of sound stools in the different Plots is as under:

Plot.	I	II	III	IV	V	VI	VII
Percentage of Sound Stools.	18	14	21	33	14	40	40

If, as might be naturally expected, we consider sound stools likely to give better coppicing results than unsound stools, we should from the above figures obviously expect better results in the June and August Plots than in the March Plot, whereas the actual results of the experiment show the reverse.

If, on the other hand, the unsound stools are regarded as likely to produce better results, then we should similarly have expected the July Plot to have shown better results than the September Plot, whereas the experiment has shown the reverse. This factor of soundness, therefore, cannot have been the dominant factor in producing the results which have been obtained.

Moreover, the proportion of sound and unsound stools in each case being approximately equal, it is obviously impossible that this factor can have been responsible for the marked differences obtained between the March and April-May-July Plots on the one hand, and between the September and June-August Plots on the other. It is interesting to note that dealing in each case with stools identical as regards their class, season of felling, height of the stool and shape of the cut surface and differing only as regards their soundness, four separate comparisons together comprising 18 trees, two dealing with trees of Class II, and two dealing with trees of Class III, were obtained from the figures of the present experiment. The results of these comparisons are shown below:—

Class.	Comparison.	Results for sound stools.			Results for unsound stools.		
		Number of Stools compared.	Average number of Dominant Shoots per Stool.	Average height of Leader.	Number of Stools compared.	Average number of Dominant Shoots per Stool.	Average height of Leader.
II	.	2	1	6′7″	2	3·5	8′11″
	b .	3	2	12′9″	3	1·7	13′6″
III	a .	2	2	11′	2	2	12′3″
	b .	2	1·5	10′4″	2	2	9′8″

These comparisons thus show that, on the whole, the unsound stools show slightly the best results, both in respect of the number of vigorous shoots developed per stool and of the height growth of the leading shoots.

As regards the stools which died and failed to produce shoots at all, the 93 trees included in the experiment produced only 4 failures, *i.e.* the very small proportion of 4 per cent. Of these failures, two stools were almost sound and two were unsound. Two stools, however, identical with these two unsound failures as regards class, season of felling, height of stool and shape of cut surface, but which were considerably more unsound, produced vigorous coppice shoots and, therefore, these failures cannot be ascribed primarily to the degree of unsoundness of the stool. These isolated instances are of course quite insufficient to justify any generalisation, but they certainly seem to indicate that a considerable degree of unsoundness, even when it extends to and includes some of the margin of the stool is not incompatible with the production of good teak coppice shoots which, at all events in the early stages of their growth, are strong and vigorous.* In view of the fact that all stool shoots originate from the healthy living tissue at the periphery of the stool we should naturally expect that a stool, with a portion of its periphery dead or decayed, having less healthy tissue from which young shoots can originate than a sound stool would have, would necessarily produce fewer shoots. The length of the periphery, however, depends mainly on the shape of the stool and it is quite possible for an irregularly shaped stool, unsound at the margin, to have a greater periphery of sound tissue than a healthy regularly-shaped stool would have of the same average diameter. Moreover, in an unsound stool the growth tends to be uneven and to produce an irregular shape.

Shape and Height of the Stool.

As regards the effect of the height and shape of the stool on the development of the coppice shoots it has already been noted in paragraph 7 above that the method of felling adopted was so far as possible kept constant throughout all the Plots, the trees being cut flush with the ground and the stool given a flat surface. At the same time, on account of the presence of rocks in the soil and other circumstances, the cut surface of the stools varied from flat to slightly dome-shaped, while the average height of the margin of the stools above the ground ranged from 0 to 1¾″. In only 5 per cent. of the stools did the average height exceed 1″. It has been considered that these differences were too slight to have an appreciable influence on the results of the experiment and it should be noted that the stools which failed to produce shoots were in no way exceptional as regards their height or the shape of the cut surface.

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* The question as to whether unsoundness is more likely to subsequently infect young shoots originating on a decayed stool than those which arise on a sound stool is not here considered. It may, however, be noted that several cases of teak coppice shoots, 13 years old, springing from very decayed stools, have been examined which, up to date, showed no sign of the decay spreading to the young shoots.

Thickness of Bark.

As regards the thickness of the bark, this is very constant in stools of one and the same class, while both the number of vigorous shoots per stool and the height growth of the leader during the first year tend to be generally greater in the case of Class III stools than with stools of Class II, whereas if the thickness of the bark was an important factor we should expect the older stools to give the poorest results.

On the whole, therefore, it appears that we may justly ascribe the results obtained in this experiment to the season of felling.

It is obviously unwise to generalize too far on the results of a single experiment however carefully conducted, and it is to be hoped that a number of others will be shortly undertaken. For the present, however, until further data become available, there certainly seems no reason to believe that, in localities where the full foliage is developed not later than the beginning of July, felling in September-October has any injurious effect on the coppice reproduction of teak and this possibly also applies to other deciduous species.*

Best Method of Felling

(15) The method of felling adopted in the present experiment was, as far as possible, flush with the ground and with a flat, or very slightly domed, cut surface. That the results were satisfactory is shown by the following considerations :—

(*a*) Although the season of felling almost certainly included the most unfavourable period, there were only 4 failures in 93 trees felled.

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* In some localities of course secondary factors have to be considered and will modify conclusions based on the normal physiology of each species alone. Shoots which arise in September to December for instance may be more subject to damage by frost in January and February following than are the shoots which originated in the previous March to June. In the case of species which are much browsed by deer also, shoots which originate in the hot season when fodder is scarce may be more liable to injury than those which arise in the rains and so on.

(*b*) The average height growth of the leading shoots which had had two seasons growth was 13′3″..

The highest shoot measured 16′4″ with a basal girth of one foot. It sprang from a stool of 9″ diameter, cut in June 1906 flush with the ground with a flat surface and was measured in January 1908. It was therefore not quite two years old.

All the coppice shoots originated in one of the two following ways :—

(*a*) From the callus-growth developed inside the bark and situated between the bark and the wood at the edge of the cut surface.

(*b*) From the side of the stool below the cut surface, the shoots appearing through the bark, just as is the case in the so-called "epicormic branches."

The (*a*) shoots are of adventitious origin and the (*b*) shoots are usually considered to spring from dormant buds. The exact mode of origin of the shoots, their structure and development, and the quality of their timber compared with that of seedling stems will, however, be shortly dealt with in another paper, which will also consider the influence upon the growth and development of the tree exercised by coppicing it at different ages. For the present it will be sufficient to distinguish the two classes of shoots as those which appear *inside* and *outside* the bark respectively, or as *callus-shoots* and *side shoots*.

In the present experiment, in all the Plots, the majority of the most vigorous shoots originated inside the bark, and out of 35 stools examined the leading shoot originated in this way in 30 cases.*

From observations made in coppiced areas elsewhere, it appears that cutting high frequently prevents the development of the callus-shoots and leads to the production of the side-shoots. This appears to be due to the rapid drying and shrinking of the wood at the cut surface which separates from the bark, the cambium layer with the living cells immediately adjoining it being killed to a considerable distance below the level of the cut surface. The formation of vigorous callus shoots at the cut surface then becomes impossible, and the shoots tend to arise from the side of the stool and from its lower portion where the cambium is still alive. It appears possible that in the case of stools cut low, and in the season of rest this injurious action may result in the death of the stool, the resting cambium and adjoining living tissues being then unable to discount the shrinkage of the wood by a correspondingly vigorous development of new cells and protective cork, the result being the exposure and death of the cambium and adjoining living tissues. In the case of a stool cut flush with the ground also the cambium might thus be killed to a considerable depth below the ground surface and there would then be little chance of any side-shoots appearing. It is believed that this explains the frequent death of stools cut low during the season of rest which has been so often reported in the case of several of our Indian species, and also the frequent recommendations which have been made in consequence to cut high. This is a point of great importance, as our Indian coppice fellings are usually carried out in November-February which is as a rule the resting period for most of our important deciduous species and it is highly desirable that further experiments on the effect of the season of felling should be made dealing with the period September-March inclusive.

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* An interesting point in connection with the place of origin of the leading shoots is that in the majority of cases where the stool was unsound the leading shoot originated close to the unsound area.

At present the evidence tends to show that with teak, at all events, felling flush with the ground immediately before growth commences and towards the close of the season of vigorous vegetative activity will give the best results, and that if felling must be done during the period of rest, felling high may be desirable in order to avoid a high percentage of failures.

The general utility of the ordinary prescriptions for coppice felling, of not separating the bark from the wood and of covering the stool with soil when possible are of course obvious.

Assistance received by the compiler of this Report.

(16) In completing the report on this experiment the writer's cordial thanks are due to Mr. A. F. Gradon, Conservator of Forests, Northern Circle, Central Provinces, under whose orders the experiment was carried out and who has given him every facility in obtaining the data and in working up the results. The writer also has to thank the Divisional Forest Officer of Jubbulpore, Mr. A. L. Chatterjee, for his ready assistance during his visit to the Division in 1908.

Finally, the excellent work done by Deputy Ranger Rahmatulla Siddiqui in connection with this experiment deserves special mention. He has taken the greatest interest in it from its initiation. The conduct of the experiment has necessitated, from time to time, the recording in the field of a large number of petty measurements which is a very troublesome and laborious task. The writer had an opportunity of checking the majority of these measurements when he visited the Plots in February

1908, and he found that the work had invariably been conscientiously and accurately done, a matter of the first importance in all experimental work.

Suggestions regarding the Procedure to be followed in future experiments.

(17) It is hoped that several additional experiments may now be initiated which will serve to correct or confirm the results which have been obtained up to date. The following suggestions regarding the conduct of such experiments are therefore made, dealing chiefly with points which were insufficiently considered in the experiment reported above :—

(1) When an area has been selected which is considered suitable for the experiment the boundaries of the plots should not be laid down until the trees on the area have been enumerated and their dimensions carefully recorded. The boundaries of the Plots can then be arranged so as to include in each Plot a sufficient number (not less than 20) of trees of approximately equal age, girth, height and soundness.

In order to reduce the extent of individual variation as regards vigour, in one and the same class, it would be advisable to have 6″ girth classes if possible instead of the 1′ classes adopted in the present experiment.

(2) It is desirable to record the girth (at 4′ 6″) of each mother tree in addition to the basal diameter or girth. One of the advantages of the latter measurement is that it can be checked at any time during the first year or two of the experiment, whereas the first cannot be checked after the trees are felled.

(3) Care should be taken to record for each mother tree selected for the experiment whether it seeded or not the year previous to being felled, also whether it seeded profusely, moderately or slightly. It is possible that the utilisation of reserve food materials in the formation of fruit and seed decreases the power of the stools to produce vigorous coppice shoots.

(4) When the mother trees are felled careful notes should be recorded of the state of the foliage on each tree at the time of felling, *i.e.* whether the young leaves are just appearing, whether the full foliage has been developed and is in full vigour, whether the leaves have begun to fall and so on.

(5) It is of great importance that all the stools should be exposed to the same conditions of light from the time of felling,

and the width of the strip to be cleared around the area will depend on the height of the surrounding trees and the configuration of the ground.

All felling debris must be carefully removed from the Plots and must on no account be allowed to interfere with the access of light to the stools.

(6) As careful a record as possible should be kept of the dates when the young shoots first appear in the different Plots and of the amount and distribution of the rainfall during the first year of the experiment, this rainfall being compared with the usual annual rainfall of the locality.

(7) The usual time for the appearance of the young foliage and for the shedding of the leaves for the species dealt with, in the locality of the experiment, should be noted.

(8) The heights of every shoot on each stool should be recorded; calculations in the field as to which shoots are to be considered dominant and which are not, are apt to lead to mistakes and the dominant shoots can be selected when the results are worked up. The disappearance of shoots previously recorded is also a useful indication of damage by deer, cattle or otherwise.

(9) When measuring the heights of the shoots care must be taken to note if the shoots are erect, or bent and nearly prostrate. Many stools of inferior vigour only produce bent and nearly prostrate shoots and must be regarded practically as failures.

(10) It is advisable that the heights should be recorded in such a way as to make a direct comparison possible between the heights of the shoots in the different plots. This can only be done if we record the heights of shoots which are of the same age, *i.e.* which have had the advantage of approximately the same period of vegetative activity. Instead of making the measurements in January, therefore, it is advisable to measure the shoots in a Plot felled say on 20th March 1906, on 20th March 1907, those in a Plot felled on 20th April 1906, on 20th April 1907 and so on. In this way the first year's measurements in all the Plots would be of shoots approximately 1 year old, the 2nd year's measurements would be of shoots

approximately 2 years old and so on, and these measurements can be directly compared.*

(11) It is probably unnecessary to continue these measurements, at all events the annual measurements, for a period of more than 3 years in each experiment, as the factors by which the probable success of coppice reproduction may be estimated will probably then have had sufficient time to declare themselves, while subsequent development of the coppice shoots may depend largely on factors other than the season of felling which are difficult to assess, such as the position of the old roots of the stool, the facility with which new adventitious roots are formed and so on.

At the same time it is most advisable to keep the experimental areas in order, to maintain the fencing until the shoots are safe from damage by deer and cattle, and to keep up the Plot boundaries and the tree numbers, as such areas are capable of furnishing valuable data regarding the rate of coppice growth, the effect of repeated coppicing and especially as regards such important questions as the power of coppice shoots to produce fertile seed and the age at which they commence to do so. It should be noted in this connection that experiments with teak coppice seed are now being conducted at the Imperial Forest Research Institute at Dehra Dun, where samples of authentic coppice seed will always be gladly received for experimental cultivation.†

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* The exact age of the shoots of course depends on the time which elapses between the felling and the first appearance of the shoots but, until data are available for this, the approximate age, calculated from the date of felling, might be accepted.

† Since the above was sent to Press the following information is available on this point:—

Mr. C. M. McCrie, I.F.S., F.C.H., in June 1908, sent the Forest Botanist a sample of undoubted teak coppice seed which he had collected himself from 9 year old coppice shoots in the Saugor Division of the Central Provinces. The seed was sown at the Imperial Forest Research Institute in July 1908, and it germinated the following June and produced healthy seedlings.

The fact has, therefore, been proved that teak coppice shoots of only 9 years growth are capable of producing good fertile seed.

The age at which the shoots first produce seed must of course depend to a great extent on the age of the mother tree felled and the nature of the stool.

It is hoped that further consignments of seed will be sent to Dehra Dun, so that some data may be obtained regarding the relative percentages of germination for seed collected from coppice shoots and seedling stems respectively.

APPENDIX.

1. It has been made clear in paragraph 12 of the above report that the conclusions regarding height, growth had to be based on the measurements which had been taken of shoots of *uneven age.* It therefore seemed advisable that for this purpose the height of the shoots in the different Plots should be measured when the shoots were approximately the same age. The writer, therefore, suggested that the shoots in all the Plots should be measured in 1909 at a time when all the shoots would be approximately 3 years old, *i.e.* the shoots in Plot I were to be measured on 20th March 1909, those in Plot II on 20th April 1909 and so on, those in Plot VII being measured on 20th September 1909. The Conservator, Mr. A. F. Gradon, very kindly had this done and the results of these measurements, which were received after the above report had been sent to the Press, are given below.

2. The first point of interest, however, indicated by the measurements taken in 1909 is that the shoots on some stools which appeared to be of fairly normal vigour in January 1908 had died in 1909, while others had become more or less bent and prostrate. The number of total and partial failures recorded in 1909 was thus in excess of the number obtained in 1908, while there was also a slight difference in the number of dominant shoots per stool calculated from the two sets of measurements. It is difficult to say, having had no opportunity of noting the development of these shoots during 1908-09 or of observing the conditions to which they were exposed, how far these differences and additional failures and partial failures can be justly ascribed to the season of felling, but the possibility of belated failures being really due to this factor must be borne in mind in subsequent experiments.

For the present, in order to see what effect this would have on the conclusions arrived at in the above report, it has been assumed that the season of felling is responsible for the additional failures, partial failures, etc., noted in 1909.

3. Taking the total failures first, the results of the observations up to 1908 inclusive, as noted in paragraph 10

of the report above, compare as follows with those which include the additional failures noted in 1909.

Number of Plot.	I	II	III	IV	V	VI	VII
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Total failures calculated in 1908.	*Nil.*	7	7	6	7	*Nil*	*Nil*
Total failures calculated in 1909.	*Nil.*	7	7	6	14	*Nil*	*Nil*

The total failures have, therefore, increased in the Plot felled in July, the results for the other Plots remaining unchanged.

4. Taking the partial failures the results compare as under :—

Number of Plot.	I	II	III	IV	V	VI	VII
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Partial failures calculated in 1908.	9	7	7	6	7	*Nil*	10
Partial failures calculated in 1909.	9	7	7	17	28	8	10

The partial failures, therefore, have increased in the Plots felled in June, July and August.

5. Taking now the number of dominant shoots per stool the results are :—

Number of Plot.	I	II	III	IV	V	VI	VII
Number of shoots per stool calculated in 1908.	2·3	2·6	2·3	1·9	1·9	2	2·5
Number of shoots per stool calculated in 1909.	2·6	2·6	1·7	1·9	2	1·4	1·9

The only material differences here are in Plots Nos. III, VI and VII felled in May, August and September, which show a decided decrease in the number of vigorous shoots per stool.

6. Finally, as regards height growth the following table gives the average height of the leading shoots in the different Plots, calculated from the measurements taken in 1909 when the shoots in all the Plots were even-aged and approximately 3 years old :—

Number of Plot.	I	II	III	IV	V	VI	VII
Average height of leading shoots when 3 years old . . .	16′ 4″	16′ 5″	16′ 8½″	16′ 4″	14′ 5″	15′ 4″	17′

These figures, therefore, support the conclusions regarding this factor of height growth which had been previously deduced from the measurements of the uneven-aged shoots, and which are stated in paragraph 12 of the above report to the effect that "The height growth shown by Plot VI appears to be only slightly inferior to that of Plot I." "The best results are shown in Plot VII while the only Plot which shows obviously inferior vigour × × is Plot V."

In considering this result also, it is to be noted that the exclusion from the present calculations of the additional failures and partial failures which occurred in this Plot V in 1909 and which would naturally be expected to be individuals of inferior vigour, if it affected the results at all, would have increased the average height growth for this Plot.

7. The figures of 1909 may therefore be summarised as below :—

Factor.	Months giving the worst results.				
Total and partial failures .	Apirl	May	June	July	...
Number of Dominant Shoots.	...	May	...	...	August
Height Growth . .	...	..	...	July	August
The worst months therefore are	April × 1	May × 2	June × 1	July × 2	August × 2

The months giving the best results therefore are March and September, and the measurements carried out in 1909, consequently, support the conclusion based on the earlier figures to the effect that:—

> " the worst period for the fellings is from the time vegetative activity commences up to, and for a short time after, the full development of the foliage; that the best season is immediately before and after this period."

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